The Dock and Harbour Authority

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Editorial Comments

The Captain Cook Dock, Sydney Harbour.

In an Editorial Comment in the June, 1946 issue of this Journal, reference was made to the completion during the past year, of two great port enterprises: one in South Africa and the other in Australia, and a description of the new Sturrock Graving Dock at Cape Town formed the leading article for that issue. Our attention is now directed to the Australian achievement, and in this issue will be found a full description of the construction of the Captain Cook Dock, Sydney Harbour, New South Wales.

As they were completed within a few months of each other, comparison of the relative merits of these two major engineering undertakings is perhaps only natural, but any controversy is to be avoided, especially as in both cases, their dimensions, design and execution have been subject throughout to the approval of the British Admiralty. As a matter of interest, however, the comparative leading dimensions of both docks are set out below:—

	Sturrock Dock, Cape Town. ft.	in.	Capt. Cook Dock, Sydney. ft.	in.
Length from Head to Entrance Copings	1,248	0	*1,177	0
Length from Head to Caisson on Main Groove ...	1,181	0	*1,097	0
Length from Head to Caisson in Outer Groove ...	1,212	5	*1,140	0
Width at entrance Coping Level ...	148	0	147	7½
Width at Chamber Coping Level ...	156	0	152	0
Depth of Sill at Entrance below L.W.O.S.T. ...	40	0	40	6
Depth of Sill at Entrance below H.W.O.S.T. ...	45	9	45	6

*Provision made for future extension by 100—200-ft. if, and when, required.

As far as the total costs of the undertakings are concerned, comparisons are meaningless, as both docks were built under war-time conditions, when the cost of construction was of less importance than speed in execution, and uneconomical methods were freely adopted if expedition of the work would result.

After the fall of Singapore and the consequent loss to the Admiralty of the only large Graving Dock in the East, Australia, which was in the front line of the Pacific struggle, had very heavy demands on her limited man-power. Nevertheless, the Commonwealth Authorities pressed ahead with the Graving Dock, the largest engineering work ever undertaken in Australia, with what labour they could spare, largely unskilled and inexperienced in heavy engineering work. The result was the work was finished in time to meet Admiralty requirements.

The dock was opened in March, 1945, by their Royal Highnesses the Duke and Duchess of Gloucester, although actually H.M.S. *Illustrious* had undergone repairs in the dock before that date. Since then, battleships, aircraft carriers and other large units of the British Pacific Fleet have used the dock which has already proved an asset of the highest value to Australia.

Dock Labour and Government Control.

At the 6th Annual General Meeting of the National Dock Labour Corporation held on the 27th June last, Lord Ammon, the Chairman, delivered a speech of considerable importance to anyone concerned with ports and shipping, and excerpts of his remarks will be found elsewhere in this issue. His statements may not be accepted in toto, but they cannot be ignored. As he rightly points out "no village in this country is more than 70 miles from an estuary" and so the state of efficiency of the ports affects the economic life of large masses of people. Therefore, when Lord Ammon was considering the grave position confronting the Corporation with its huge surplus of dock labour and seriously depleted finances, he was right to direct the attention of the industry and of the Government to the need for reviewing the matter as one aspect of the whole port problem. Efficient ports are essential to the well-being of almost all industries, and they are also vital to the defence of the country—a point we remember the Foreign Secretary making some years ago. The problem cannot be ignored without jeopardising our future as a Nation. As Lord Ammon says, a Government statement on Port Policy is to be expected; it should not be delayed, because until this is known, there will be hesitation in the minds of those concerned with Port Administration as to the plans they should now be undertaking for future development.

One of our shipping contemporaries recently tiraded against this reference, by Lord Ammon, to a national policy. They attributed to him statements which we have not found in his speech and which cannot be deduced therefrom. He did not say that the ports should be managed by the Government, but he did assert that old laissez-faire practices must be tempered to modern and national requirements. "The natural inter-play of economic forces must be harnessed to the best interests of the whole community."

We are not prepared to agree with Lord Ammon's detailed application of this over-riding principle, but it is no use adopting A Canute-like attitude to the new conditions hoping that, in the words of our contemporary, the "caprice of local enterprise, by being given a free hand" can solve the many problems affecting this and other industries.

Editorial Comments—continued

The National Dock Labour Corporation was given a most formidable task which, on the whole, it has discharged with vigour and credit. The enemy was at the gates; all but the Western Approaches were closed. The alternatives were either to man the docks with military personnel or create a civilian labour force willing to stand by ready to unload such ships as in the early days succeeded in running the enemy blockade, and, later, the increasing number of convoys which reached more ports as the sea lanes were cleared. The Government chose the latter course and the Corporation was hurriedly formed for this purpose. There was no staff, equipment, or office. The dockers, who, in return for attendance monies, were required to turn themselves into a disciplined body, were by tradition, practice and character, essentially free lances. The younger men had been called to the Forces; there remained, therefore, only the older men, many of them strange to their locality, to deal with the ever-increasing volume of imports and exports.

The Corporation, the employers and the unions were working under high pressure and in difficult conditions, and, of course, some mistakes were made. The fact remains, however, that in spite of air attacks and a heavy death roll at the docks, the job was done. In the present transitional period, the work at the ports is slacker, and the Corporation is consequently facing a grave financial difficulty, and we suggest it would be more becoming to recognise these facts rather than to use the occasion for unbridled criticism.

Let us be realistic. The Government has this year passed a measure supported by all sections of both Houses, assuring the decasualisation of the dockers, and this Act will be implemented in July, 1947. The experience of the Corporation must, therefore, be closely examined in order that the future may be carefully planned. Lord Ammon's statement quite rightly was no apologia; it was a call to the industry to lay its plans now for the present and future efficiency of the ports.

The Proposed St. Ives Harbour of Refuge.

Harbours of Refuge are a limited and special class of harbours the main function of which is entirely distinct from any form of commercial exploitation. In the days of sailing vessels, they undoubtedly served a very useful purpose in providing, on exposed and dangerous coasts, temporary shelter for vessels caught in sudden and unexpected storms, and, as such, they were constructed at the national expense, since the cost was quite beyond local resources. With the advent of more powerful propulsion by steam and oil, combined with the larger size of vessels, there has not been the same necessity for meeting emergencies of the kind in question, except in a few instances, mainly associated with the fishery industry, in which sailing craft are largely engaged and, indeed, form a very large and important contingent. Unfortunately, the industry, though an essential activity of an island community, is not financially in a position to provide in many instances adequate shelter for the furtherance of its operations, and has to rely on Government assistance, so that it is the practice of the Development Commission Small Harbours Committee to make grants in necessitous cases.

The case of St. Ives has been previously mentioned in these columns on several occasions, and we are led to a further consideration of its claims by the receipt of a statement recently issued by the St. Ives Harbour of Refuge Joint Committee, the salient points of which are extracted and included in the present issue. The statement sets out in detail the arguments for the construction of a harbour of refuge at the Cornish fishery port and makes an appeal for public support of the project, which though convincingly advocated and sympathetically received, has failed to obtain a financial subsidy from the Government, despite frequent and influentially backed applications. The merits of the case are so obvious that it may be wondered on what grounds it is rejected. The reason may be found in the following extract from the Report on Sea Fisheries for the year 1924, which runs as follows:—

" It is contrary to the practice of the Development Commission to recommend a grant in the case of a harbour already in existence attached to a town of any size, unless a considerable contribution to the cost of the work from local sources is assured. Examples of such harbours are . . . . St. Ives."

Whatever be the justification of this official attitude it bears rather hardly on the town in question, which, though it may be of some size, has mainly a population of humble fisher folk, and is not in a position to make any " considerable contribution " towards an undertaking estimated to cost anything from half to three-quarters of a million pounds. The suggestion is made, however, that this figure may be reduced by the utilisation of some of the Phœnix Caissons, which figured in the war-time " Mulberry " harbours on the Normandy Coast.

In any case, in view of the exposed nature of the Northern Cornish Coast, and on grounds of humanity and in the interests of the fishing industry, carried on as it is by a brave and hardy race, of which this country has every reason to be proud, it is to be hoped that the present appeal will meet with a prompt and liberal response.

We do not attempt to comment on the plan of the proposed harbour put forward with the statement. For lack of knowledge of the coastal environment, we are not in a position to pronounce judgment. But one thing is evident: the question of silting will require very careful consideration since accumulation of coastal drift in the enclosure is almost inevitable and occasional dredging operations may be necessary to keep the harbour entrance clear.

Two Technical Institute Appeals.

In these days of outstanding corporate development of specialised technical interests, it is not altogether surprising that two leading institutions should find it necessary to make appeals to the public for support of proposals they have in mind for providing themselves with more suitable and commodious headquarters than they at present possess. Both the Institute of Transport and the Institute of Marine Engineers have rendered conspicuous service in the past in their respective spheres, and they now feel the time has come for the acquisition of appropriate centres from which to direct and foster their future and more widely extended activities, which cannot be undertaken effectively without the prestige and scope afforded by official headquarters of dignity, spaciousness and standing.

The Institute of Transport though comparatively young (it celebrated its silver jubilee in 1945) has attained a membership roll of over 6,500, and of its value to the community there can be no question, seeing that it caters for the well-being of a vast network of public travel and traffic agencies. Included in its wide purview is the field of ports and shipping, which is the special interest of this Journal. It has been our privilege in the past 25 years to record much of the information contained in the proceedings of theInstitute, which has been serviceable to our readers. And we expect that there will be a good deal more in the years to come. The target set by the President, Sir F. Handley Page, is £100,000, of which some £40,000 has already been promised by a number of the great traffic organisations in the country. Were the situation not complicated by the various schemes of nationalisation for the traffic industry at present in the air, it might pertinently be asked whether it would not be appropriate for a Government grant to be made towards the educational objects which the Institute has in view. The fostering of the intellectual side of transport cannot fail to be in the public interest and, indeed, is a matter of national concern.

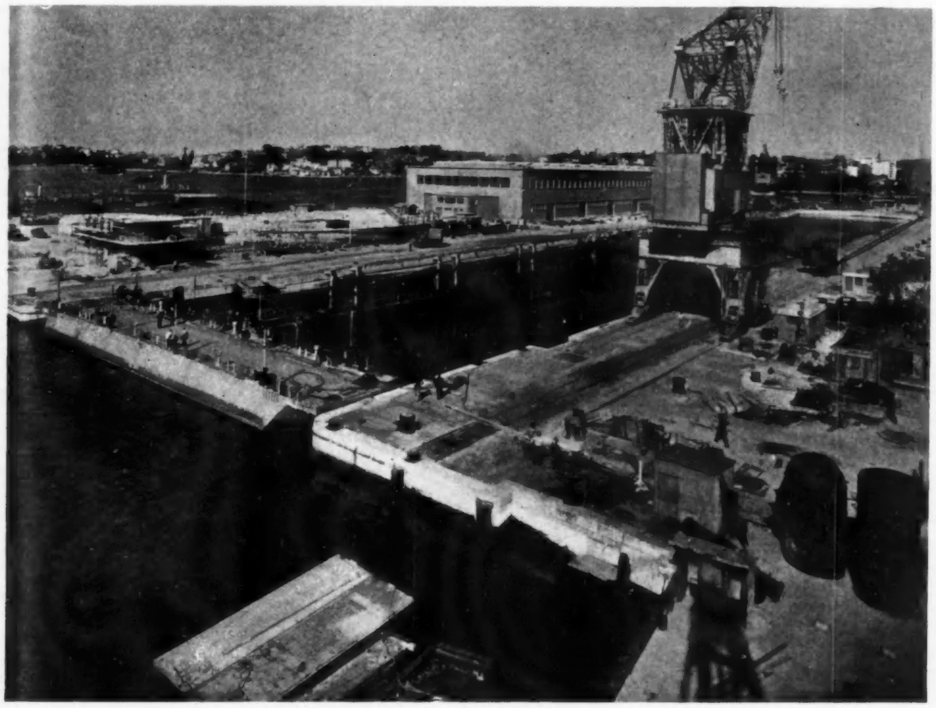
The joint appeal of Sir Amos Ayre and Sir William Currie, President and Past President of the Institute of Marine Engineers, strikes a patriotic note. It invokes the gratitude of the public for the heroic self-sacrifice of some 3,500 marine engineers who gave their lives in the national service during the momentous years of the war, when the lives and liberties of all in this country were at stake. Much has been done by the Institute to promote the interests of the profession and to improve the status of its members and it is claimed with every justification that there is ample scope for further development. The Council have in mind in their headquarters scheme the provision of a Lecture Hall to be known as the Memorial Hall and a Library, both considerably larger than those in the existing building, together with a Council Chamber, Committee Rooms, reading and Writing Rooms, as well as the necessary office accommodation. The target in this case also is £100,000.

The Captain Cook Dock, Sydney Harbour

An Outstanding Australian Achievement

Consulting Engineers: Sir Alexander Gibb & Partners, Westminster.

IN 1939 the Australian Government decided to construct a graving dock capable of accommodating the largest naval or merchant vessel afloat. There was at that time no dock in Australia capable of dealing with the major ships of the British Navy or with such ships as the *Queen Elizabeth*. The decision was not lightly nor suddenly taken. The Commonwealth had been considering such a dock for some time, but the turn of international affairs had made the decision one of immediate moment. With war imminent it was realised that a first-class graving dock might be a vital factor in the defence scheme of the Pacific and Indian Oceans, and of Australia herself. It would form a proper complement to the facilities already existing at Durban, Singapore and British Columbia. But apart from these reasons of defence it had been long realised that if Australia hoped to attract large merchant ships to her ports, docking and repair facilities must be provided for them.



View of Dock showing Caissons in outer and inner positions with 50 ton crane in foreground. There is a 50 ton crane on each side of the dock.

The Commonwealth Government accordingly invited Sir Alexander Gibb & Partners, of London, to report on the project and advise on the most suitable locality for the dock. Sir Leopold Savile, a partner of the firm, visited Australia for the purpose and investigated various places at each of the eight large ports of the southern division of the Continent. He recommended that the dock be built at Sydney, on a site down river from Sydney Harbour Bridge, between Garden Island and Pott's Point on the mainland. A site above the bridge, otherwise suitable, was rejected because of the danger of access to it being blocked by wreckage of the bridge structure in the event of a successful enemy bombing attack. Moreover, the Pott's Point Garden Island position had the advantage that it greatly improved the facilities of the Royal Naval Base on Garden Island by providing it with one of the largest graving docks in the world, and a large and up-to-date fitting-out wharf. Also it give Garden Island direct access to the mainland by road and increased its area by 35 acres of reclaimed land. There was the further advantage that the approach to the dock would be along a superb deep-water channel at the entrance to Woolloomooloo Bay, sheltered from storms by Garden Island, and protected from enemy attacks by the fixed defences of the naval base. Geological conditions were also very favourable, a very suitable rock foundation being found on the submerged ridge joining the island and the mainland. Nearby are the great steel plants of Newcastle and Port Kemble and Sydney itself is one of the most highly industrialised centres in Australia.

The principal dimensions of the dock are as follows:—

	ft.	in.
Length from entrance to cope at head of dock ...	1,177	0
Width at entrance at cope level	147	7½
Width of dock at cope level	152	0
Width of dock at level of docking blocks	140	0
Depth from cope to entrance cill	50	6
Water over blocks and entrance cill at M.H.W.S.	45	3
Batter of the walls at entrance	1 in 8	

The dock in constructed of mass concrete throughout and was built in the dry in a cofferdam enclosing the whole area between Pott's Point and Garden Island. The space between the dock walls and the cofferdam embankment was reclaimed and was used for the construction of two wharves (the East Wharf, 360-ft. long and the West Wharf, 486-ft. long), forming an entrance bay leading to the dock. A workshop and other accessory buildings with road and rail access were constructed in this area, but the fitting-out wharf which formed one limit of the reclaimed area was built just outside the area of the cofferdam. The cofferdam was made of two embankments, one running out from the east shore of Pott's Point and curving to meet the south end of Garden Island, the other running from the north shore of Pott's Point and curving round to meet the west shore of the Island. Within this area the dock was set out on a north-south line, with its entrance facing north.

Before construction began, the site had been carefully investigated, more than 200 pipe and wash bores having been taken, and 22 diamond drill bores giving 3-in. diameter cores. All the water mains, electric power and telephone cables between the mainland and Garden Island crossed the site and had to be moved and re-located before work could begin on the cofferdam late in 1940.

The embankments of the cofferdam consisted of sandstone ballast banks retaining a centre core of clay laterite. A single row of steel sheet piling was driven to rock level along the centre line of each embankment through the middle of the core. Mostly pile lengths of 60-ft. were sufficient, but along a portion of the south-east embankment 70-ft. lengths had to be used. Before closing the cofferdam alternate piles over a length of 200-ft. were cut through at low water level and the upper lengths raised and wedged. When

Captain Cook Dock, Sydney Harbour—continued

the water inside had poured through the openings thus created, and had attained its minimum level at low water, the wedges were removed and the raised portions of piles were driven back to close the gaps. The length was sealed with clay and the bank completed with ballast protection. To facilitate the flooding of the dock when constructed, two 21-in. pipes were built into the western bank with their centres 2-ft. below low water.

During the construction of the cofferdam, two dredgers removed as much as possible of the soft material overlying the rock on the dock site. They were withdrawn before closing of the embankments, having removed some 170,000 cub.yds. of clay and sand which was used for reclamation purposes.

De-watering of the cofferdam commenced in February, 1942. It was effected by pumps mounted on barges discharging through a flexible jointed pipe line leading over the embankment. Generally, pumping went on for about 2½days when the level had been lowered some 5-ft., followed by a halt of 2 to 3 days to allow for drainage and consolidation. Some settlement and some lateral movement of the sheet piling took place, but there was no movement serious enough to cause trouble or apprehension, and the cofferdam proved thoroughly effective, a maximum leakage of about 1 cub. ft. per second having to be dealt with. Considering the 75-ft. head and some 4,000-ft. of embankment this must be considered very satisfactory and reflects well on the design and its execution.

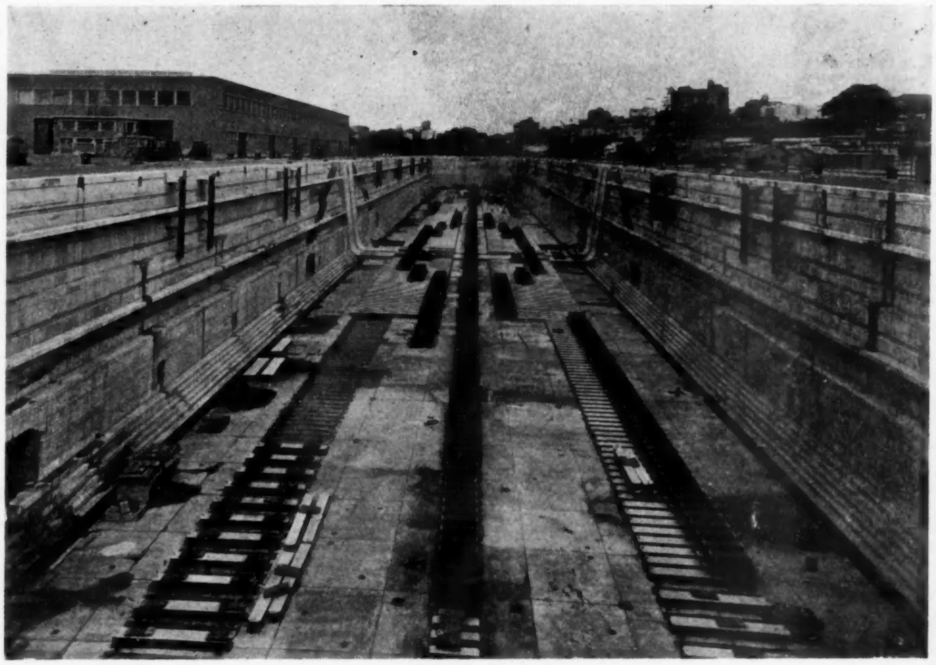
Excavation commenced as soon as the exposed sea bed had dried sufficiently to bear the weight of the excavating plant, of which several kinds were used. Spoil was removed in motor trucks and mostly placed on the inner slopes of the embankments to form part of the permanent back-filling.

The rock formation did not form an even surface, falling away at the north-west and south-east corners of the dock. On the highest part it turned out to be of so much higher quality than expected that it was decided to reduce the minimum thickness of the floor from 8 to 5-ft. In the north-west and south-east excavation went lower, the deepest being 70-ft. below low water, resulting in a maximum floor thickness of 25-ft.

The floor has a level strip 20-ft. wide along the centre. From this is slopes each side at 6-in. in about 50-ft. to dock drainage channels. For the purpose of concreting, it was divided into sections, generally 22-ft. 6-in. long by 20 to 24-ft. 9-in. wide. These sections were concreted alternately, with as far as possible, 6-week intervals between the concreting of contiguous blocks in order to allow for contraction of the masses of concrete while setting. It was necessary, however, to depart from this rule in the laying of the two outer strips which carried the Telpher Transporters used during construction, but in this case provision was made for grouting between the units. Concreting was first brought up to a level of 2-ft. below final level of the floor to provide a surface for use during construction. Later it was completed with a 1-ft. 8-in. layer of richer concrete, finished with 4-in. of granolithic surfacing. The granolithic layer was placed in panels measuring about 12-ft. by 11-ft. which prevented crazing cracks forming during its setting. To guard against hydrostatic uplift developing under the floor, a drainage system was provided under each block leading to a 4-in. diameter vertical pipe. These vertical pipes terminate at floor level with a hydrostatic ball relief valve which allows water to escape from under the floor, but prevents it gaining access there when the dock is flooded. As a further safeguard against uplift, pressure-grouted cut-off walls are provided under the entrance cill and the cill for the intermediate caisson.

The dock walls are of gravity section, generally 41-ft. 6-in. at the base, 31-ft. wide at bilge altar level and 13-ft. 7-in. at the top, which allows for four continuous altars at various heights, with a bilge altar and steps at floor level. Within the walls are two subways passing right round the dock; the upper subway containing electric cables, fire, fresh water and compressed air mains, and the lower subway a 21-in. diameter salt water main for the supply of ships in the dock. These subways are connected by vertical shafts at intervals and again by a connecting subway running under the entrance sill and carrying the electric cables and service mains below the dock. To guard against the danger of the underground pump house being flooded through damage to these subways, they are isolated from the pump house by steel watertight bulkheads, and their drainage directed to a separate small pump. Should the necessity arise at any time this drainage can quickly be diverted to the main drainage pumps in the pump house. For filling the dock two culverts are provided, one on each side of the entrance. They take off from the return walls and run behind the dock walls for some 130-ft. when they bi-furcate, one branch going to sumps near the entrance, the other to the sumps in the inner portion of the dock. That culvert which is on the same side of the dock as the pump house has two other branches leading to the pump house suction chamber so that they can be separately used for emptying the inner or outer dock. For emptying the dock three 6-ft. diameter culverts connect the discharges of the three main pumps in the pump house to the entrance channel. A further 6-ft. diameter culvert for impounding the dock, leads to the pump house suction chamber and this can be used when required as an auxiliary filling culvert.

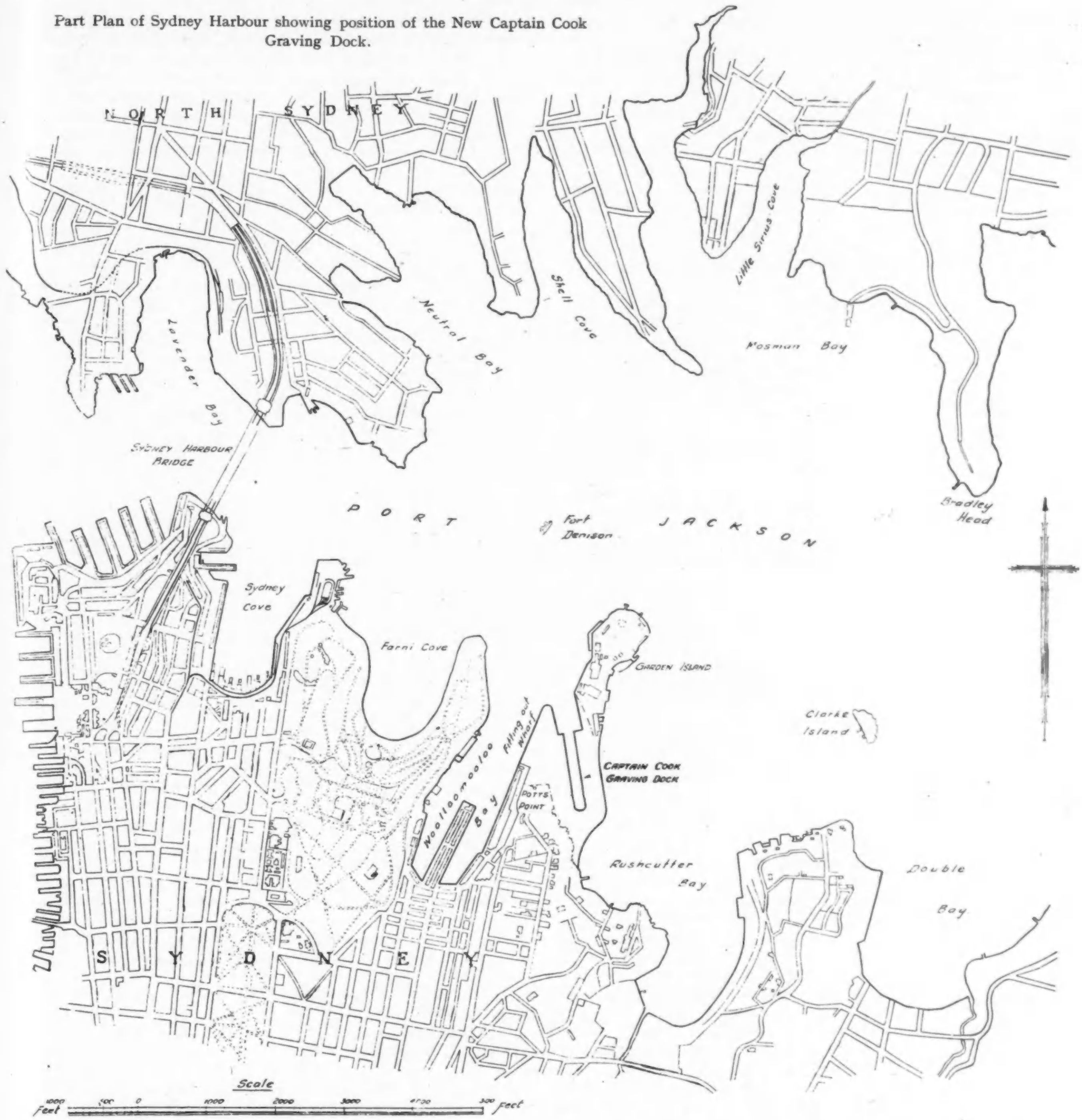
The walls, like the floor, were built in separate units, lengths of 40-ft. being separated by 5-ft. gaps. The 40-ft. lengths were built first and then left for 8 to 12 weeks to allow for shrinkage of the concrete before concreting the gaps, thus confining the shrinkage to 5-ft. of the concrete. To make the joints watertight 6-in. diameter holes were formed across the construction joints, which after being thoroughly heated and dried were filled with a tough plastic bituminous compound. The joints surrounding the subways were sealed by bent copper strips built in during



View from Outer Caisson towards head of Dock showing docking blocks being placed in position. The Intermediate Caisson Grooves can be clearly seen. Workshops for repairs, etc. are on left.

Captain Cook Dock, Sydney Harbour—continued

Part Plan of Sydney Harbour showing position of the New Captain Cook Graving Dock.



construction. All these measures have been very successful in preventing leakage into the dock or subways.

For concreting the floor and walls a mixture with a cement content of $4\frac{1}{2}$ cub. ft. per cub. yd., and 3-in. aggregate was used, but mixtures containing 11 cub. ft. of cement per cub. yd. were used in some of the culverts where high velocities and turbulence were likely to occur. All concrete was compacted with internal vibrators operated by compressed air. Nearly all concrete used was mixed in a central mixing plant on Pott's Point. Thence it was delivered to the floor of the dock in 1 cub. yd. skips which were taken by Diesel locomotives to the overhead Telpher Transporters which lifted the skips, conveyed them to where needed, and deposited the concrete.

The dock is closed by a floating caisson gate, and a second caisson is provided for dividing the dock into two sections. There are three grooves lined with granite blocks to take the caissons, an outer emergency groove, and a main groove at the entrance, and an intermediate groove about one-third of the way up from the entrance. Each caisson is 151-ft. long, 37-ft. wide and 52-ft. deep, and has a displacement of 3,655 tons at a draught of 33-ft. 6-in. They are all-welded steel construction. The ends have a batter of 1 in 8 to correspond with the grooves in the dock wall. Each has a 16-ft. diameter ballast tank running its full length, and tidal chambers on each side just above normal water level. In sinking the caisson, water is first admitted into the ballast tank and when it has sunk far enough to bring the tidal chambers below water

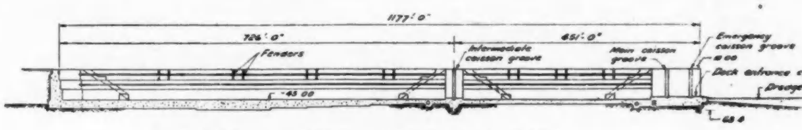
Captain Cook Dock, Sydney Harbour—*continued*

level, these chambers are flooded through valves, till the caisson has sunk to its proper position in the grooves. In raising the caisson the ballast tank water is forced out by compressed air, the tidal chamber valves being left open, so that the tidal water flows out by gravity. The design and the leading dimensions of these caissons were made by Sir Alexander Gibb & Partners, Messrs. Vickers Armstrongs, Ltd., providing the detailed design. The two caissons were constructed inside the cofferdam.

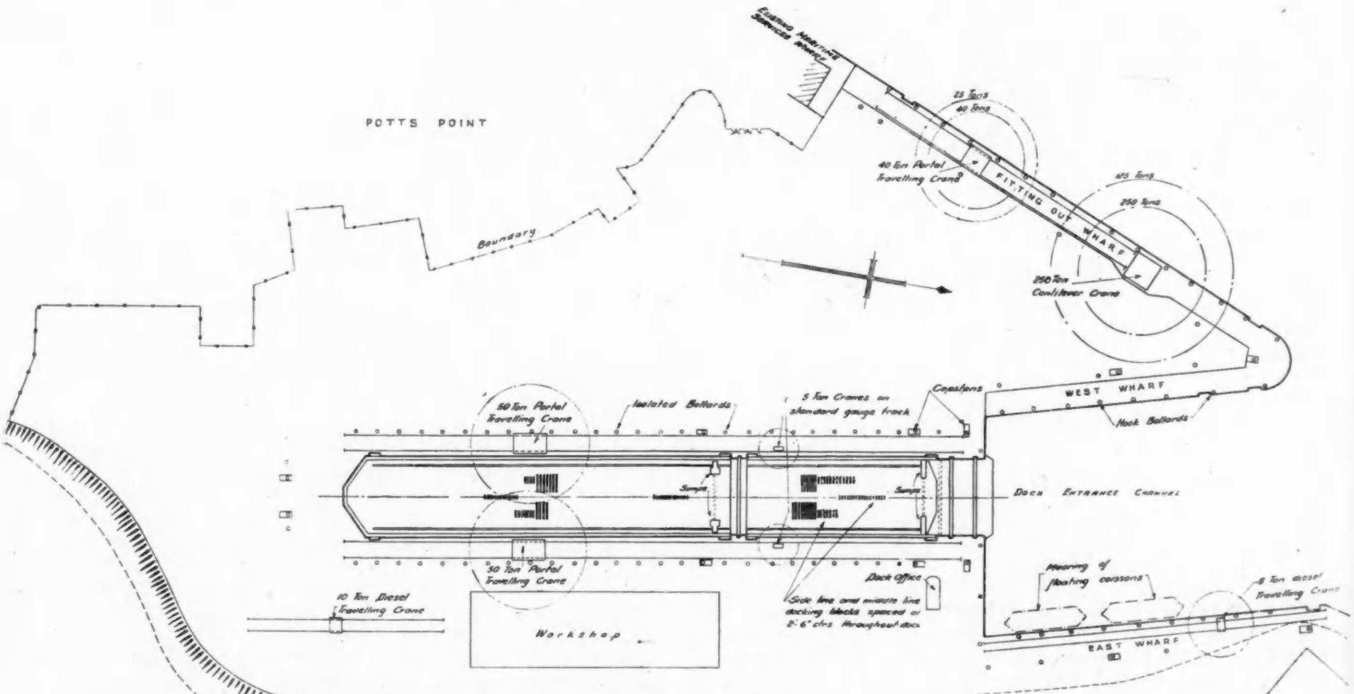
The pump house is located underground. It is of reinforced concrete, 140-ft. long by 40-ft. wide. There are three main pumps of the horizontal spindle, centrifugal type, provided by Messrs. Gwynnes Pumps, Ltd., the principal contractors for the whole of the Pump House equipment. The pumps are 60-in. diameter suction and 54-in. discharge, driven at 272.7 r.p.m. by synchronous motors of 1,000 K.V.A., operating on 5,000-volts, provided by the General Electric Co., the contractors for the electrical equipment. With each pump working at 75,000 g.p.m. the dock can be emptied in 4 hours. The Pump House also houses pumps dealing with dock drainage and seepage water, two fire pumps capable of delivering 1,825 g.p.m. to a head of 270-ft. and three circulating pumps for delivering salt water to ships from the 21-in. diameter salt water main in the lower subway. All pumps and main valves are centrally controlled and the whole system is electrically inter-locked; the main valves were supplied by Messrs. Glenfield & Kennedy, Ltd. A mimic diagram in the Pump House enables the operator to follow clearly the whole sequence of operations throughout the dock, including the working of the remote culvert valves and the drainage, tide and dock water levels.

The dock is equipped with two 50-ton electric Portal Travelling Cranes, each with a radius of 110-ft. and a lift of 100-ft. above cope level, also a travelling speed of 60-ft. per minute with a 50-ton load. Each of these cranes has, in addition, an auxilary hoist with a 15-ton capacity at 120-ft. radius. There are also two 5-ton cranes running on standard gauge tracks, and two 5-ton mobile cranes. Two Diesel locomotives are supplied and use the standard tracks. The Portal Travelling Cranes are carried on heavy rails (111 lbs. per yard) at 30-ft. centres, the front running on the top of the dock wall, the back on a reinforced concrete beam resting on 18 by 18-in. piles at 6-ft. 8-in. centres, driven to rock. As the cranes straddle the standard tracks, they are specially designed to give clearance under their superstructure for the Diesel locomotives, the 5-ton cranes and other traffic. For handling ships entering the dock and to help bring the caisson gates into position, there are 12 electric capstans with a pull of 20 tons each, at a speed of from 10 to 40-ft. per minute.

The workshop is on the east side of the dock. It is of steel frame construction, 450-ft. long by 140-ft. wide and is divided into two bays, founded on 18 by 18-in. reinforced concrete piles driven through the made-up ground into the former sea bed for some 20-ft. Concrete bases for the heavy machinery had also to



LONGITUDINAL SECTION THROUGH THE DOCK



PLAN

SCALE 100 FEET TO INCH.

Captain Cook Dock, Sydney Harbour—continued

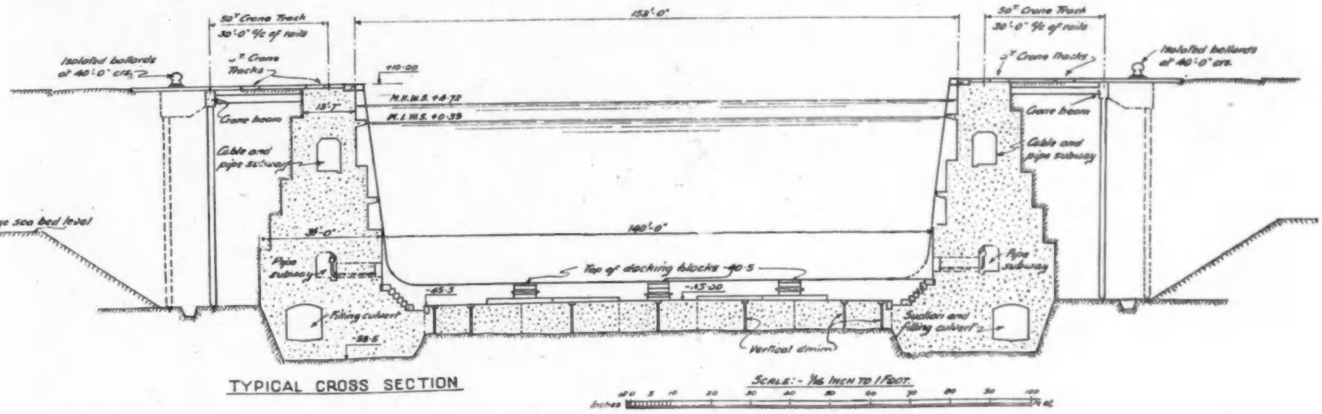
be founded on piles. This was necessary because the whole dockyard is built on newly reclaimed ground. The shop is fitted with the most up-to-date machine tools, including two overhead travelling cranes, one of 60 tons and one of 10 tons lifting capacity.

The supply of electricity for the operation of the dock is obtained from the Sydney Electricity Supply, but to provide for the possible failure of this supply, a stand-by power house of reinforced concrete was constructed on the site. This has been built underground and houses three Diesel alternators of 1,000 kw. each, one 500 kw. motor generator to supply direct current to ships, one 160 kw. motor generator for providing constant current for the dock capstans, two air compressor units, a 5,000-volt and 445-volt switch gear controlling the supply of electricity to the various sub-stations constructed within the dock area.

These sub-stations have been constructed on the site and are also underground. They contain transformers for the subsidiary pumps, a motor generator for direct current for ships in dock and a motor generator for the supply of constant current for the operation of the capstans.

The fitting-out wharf, as already stated, was constructed outside the area enclosed by the cofferdam, the dredged level in front of it being about 47-ft. below low water. Commencing where the existing Maritime Wharf at Pott's Point ends, it runs from there for 840-ft. to join the West Wharf at a roundhead at the entrance to the dock approach channel. The wharf consists of reinforced concrete rigid frames spaced at 30-ft. intervals, the vertical members of which are cylinders at 40-ft. centres. The cylinders are 15-ft. in diameter at the base and are each supported on twelve turpentine timber piles driven to rock. At sea-bed level the cylinders are reduced to 7-ft. 6-in. in diameter continuing up to about low water level where they are joined by heavily reinforced and haunched concrete portal beams providing the necessary transverse bracing. The deck is 16-in. thick surfaced with tar macadam and supported on three longitudinal beams at the front, centre and back of the wharf. Expansion joints are provided in the beams and deck at about 300-ft. intervals.

In the construction of the wharf, 15-ft. diameter steel cylinders were sunk into the sea bed to about 58-ft. below low water level,



TYPICAL CROSS SECTION

Additional buildings included within the dockyard area are the dock office, main office, timekeeping and police office, painters' and dockers' store, dining room and kitchen, mould loft and amenity buildings. About 6 miles of railway and 3 miles of road were also constructed complete with sewerage, water supply, gas and electricity installations.

The East Wharf, which forms the Garden Island side of the entrance channel to the dock, was constructed in the dry inside the main cofferdam. It is a heavy reinforced concrete counterforted wall founded on rock with a dredged level in front of it of 43-ft. below low water. It was the first part of the job to be completed, so that on its rock back-fill being deposited, it could be used as a platform for the cranes and equipment used in the construction of the two floating caissons. These caissons were constructed in front of this wharf, so that when the cofferdam was flooded they could be floated into their position in the dock while the closing length of the cofferdam bank across the approach channel was removed.

Before the cofferdam was flooded the West Wharf forming the other side of the entrance channel was constructed. This wharf is of reinforced concrete supported on 18-in. square pre-cast concrete piles driven to rock. These are in groups of two at 20-ft. centres transversely, supporting frames spaced at 15-ft. centres along the length of the wharf. The frames are each braced by means of pre-cast concrete A frames, and are inter-connected by the concrete walings, deck beams, deck and a deep beam at the back retaining the earth fill. The thrust from the earth fill is partially taken by raking some of the piles and by an anchor beam in the earth-fill, supported on timber piles. A 5-ton Diesel crane services this wharf which has a 43-ft. depth of water at low tide, and the necessary services of compressed air, electricity and water are all provided. A small portion of it, the site of which was occupied by the cofferdam embankment, has yet to be constructed, and this will extend it to a roundhead at the end of the fitting-out wharf.

so that they entered into stiff clay. This clay was removed from inside the cylinders by air lift ejectors after it had been cut by a diver using a high pressure air and water jet. Timber piles were then driven to rock with the aid of a long steel follower, after which concrete plugs were placed by tremie tubes. On this being completed, the steel cylinders were de-watered forming cofferdams in which the 7-ft. 6-in. diameter concrete cylinders were constructed in the dry up to about low water level. Subsequently the steel cylinders were disconnected and removed and the deck beams then constructed. Before the concrete deck was placed, a rockfill bank was deposited under the wharf and brought up to about 9-ft. below low water level to retain the earth fill. Above that level the earth fill was retained by pre-cast concrete beams supported by the back cylinders and spanning horizontally between them.

The wharf is provided with the usual compressed air, fresh water, fire and electric services and a 40-ton electric portal travelling crane of the same type as those supplied for the dock. The superstructure of this crane, however, was built higher to clear aircraft carriers berthed at the wharf. The crane can lift 40 tons at 90-ft. radius to a height of 150-ft. above low water. The firm of Messrs. Stothert & Pitt, Ltd., supplied this crane and the two cranes for the dock.

Exceptionally heavy loads, such as the guns and gun turrets of battleships will be handled by a large fixed cantilever crane of 250 tons capacity situated on the wharf at about two-thirds of its length from Pott's Point. This crane will be capable of lifting 125 tons at 165-ft. radius or 250 tons at 118-ft. and it has a height of about 150-ft. above deck level. The uppermost parts of the superstructure of this crane will, when completed, be at a level higher than the deck of the Sydney Harbour Bridge, while about 1,600 tons of steel will be required for its fabrication. Sir William Arrol & Co. designed this crane and supplied all the machinery for it, the structural steel superstructure being made to their detailed design in Australia.

Captain Cook Dock, Sydney Harbour—continued

Aerial View showing H.M.S. *King George V* entering Captain Cook Dock, November 1945.

The legs of this large fixed crane are supported on reinforced concrete cylinders of 15-ft. diameter at 50-ft. centres and carried down to be founded on rock at 100 to 110-ft. below low water. The diameters of them are increased at the base to 20-ft., and above low water they are inter-connected by heavy reinforced concrete beams. The 16-in. concrete deck supported by these beams is at the same level as that of the wharf of which it forms a part.

Although the decision was reached in 1939 to build the dock, it was not until the Summer of 1941 that construction on it commenced. All the cranes and practically all the large pumps, capstans and heavy machinery had to be imported from Great Britain, so that the entry of Japan into the World War in 1942, added greatly to the hazards to be overcome. The firm of Sir Alexander Gibb & Partners were engaged to carry out the design, supply specifications and supervise the construction work, and since the dock had to be capable of docking the largest ships of the British Navy, they as Consultants, worked in close liaison with the Admiralty. A Dock Construction Section of the Department of the Interior was formed by the Commonwealth Government to control, co-ordinate and supervise operations and they arranged that those State Departments who had suitable plant and staff available should carry out various parts of the work. The several firms in Great Britain who had supplied the machinery and cranes sent out staff to supervise the installation and erection of those.

The dock was opened on 24th March, 1945, by the present Governor-General of Australia, H.R.H. The Duke of Gloucester, and named "The Captain Cook Dock," by H.R.H. The Duchess of Gloucester. The first vessel to be docked was the aircraft carrier, H.M.S. *Illustrious* on 1st March, 1945, and since then the dock has been widely used by the Admiralty for many of their largest vessels in the Pacific. The dock, therefore, played an important part in the closing stages of the war against Japan and since it is capable of docking liners of the "Queen Elizabeth" Class, it should prove its worth not only in a naval capacity, but as a great asset to the increasing peace-time shipping requirements of Australia.

Quick Dispatch at Plymouth.

An instance of the quick dispatch given to vessels at the G.W.R. owned Milbay Docks, Plymouth, is reported in the case of the "Samwater," which arrived at Plymouth from the Pacific Coast of Canada with a cargo of lumber and grain, consisting of 1,386 standards of timber, 400 tons of plywood and 2,787 tons of wheat. Discharging operations began on June 17 and were completed on July 7th. The net number of gang-hours worked on the timber and plywood cargo was 482 hours and gave an average of 4.16 standards per gang-hour. The number of hours worked on the wheat was 61, giving an average of 45.7 tons per hour.

The National Dock Labour Corporation

Speech of the Chairman at Annual General Meeting

The Sixth Annual General Meeting of the National Dock Labour Corporation, Ltd., was held in London on 27th June last and the Chairman, The Rt. Hon. Lord Ammon, P.C., D.L., J.P., made the following amongst other observations:

Management Fund

Turning first to the Balance Sheet, it will be noticed that the year's working resulted in a deficit of £310,476, which reduced the balance on the Management Fund brought forward from the previous year to £288,798. But for the transfer of £316,710 from the Reserve Fund, to which I will refer later, we should have started the current year with a seriously depleted balance, instead of the carry forward of £605,508.

The chief causes which produced the deficit for the year were the unexpectedly rapid defeat of Japan, the termination of Lend-Lease shipments which resulted in a much earlier and greater disorganisation of the forward programmes than could be foreseen, and the difficulty of adjusting a rising Labour Force to current and future requirements.

In view of the important arrangements made during the year concerning the Reserve Fund, to which brief reference is made in the Directors' Report and the Balance Sheet, some additional comment will not be inappropriate.

When the Corporation started, your Directors decided to set up a Reserve Fund to provide against the uncertainties arising from the operation of Dock Labour Schemes. Eventually, the levy for the Reserve Fund was discontinued and the monies invested in Government securities. We had to resist strenuously the argument that these Reserve Fund monies, having been derived almost wholly from Government sources, should be paid over to the Treasury or used, at that time, to reduce the rate of percentage levy.

It seemed to us, however, that some portion of these monies could properly and usefully be expended on Welfare Schemes for Port Transport Workers in Corporation Ports, as had been done in War Transport Ports, the need for which both my predecessor and I have continually stressed. In this view we had the encouragement of the former Minister of Labour, the co-operation of his officers and the concurrence of the National Joint Council.

Eventually, the Treasury agreed that, of the monies accumulated in Reserve Fund the Corporation should hold £500,000 for approved expenditure on Welfare—on condition that the remaining £316,710 should be transferred to Management Fund and that any part of the half-million pounds earmarked for Welfare, and ultimately not so used, should similarly be transferred to the Management Fund.

Income and Expenditure Account

The Income and Expenditure Account, to which I now turn, shows most clearly the effect of the declining volume of employment, Income from Percentage Payments having fallen by about £200,000. Although expenditure on Attendance Money showed a reduction of about £30,000, there were special "V" payments costing just under £140,000.

The increased Labour Force resulted in higher Administration Expenses; but, when comparing the component items with the figures for 1944, salaries and wages should be read in conjunction with Accounting Agents' Charges since, in the latter half of 1944, we were in the process of taking over the work of accounting agents in certain ports.

Present Position

The Corporation has set up and operated Dock Labour Schemes since 1941 under the Essential Work Order. By July of next year, such schemes as may be operative will be under the Dock Workers (Regulation of Employment) Act, 1946. Our experience may, therefore, be of special value as the current year has thrown into high relief some of the problems of decasualising this industry.

Most of the items of Income and Expenditure are determined by factors outside the Corporation's control. For example, the Docks' Agreement of December, 1945, increased the daily minimum time rate of pay from 16s. to 19s., thus potentially increasing our income. The same agreement also increased our liability in respect of Annual Holidays and added, as a matter of Industrial Agreement, Statutory and Proclaimed Holidays; these charges alone are likely to show an increase of over £150,000 in respect of the present year.

There are other factors beyond the control even of the industry itself. The present volume of shipping, for example, depends in no small measure on the state of international affairs and this fact, in part, accounts for over 8,500 men proving attendance daily since the beginning of the year.

Over 4,000 Supplementary men who, at the time of their engagement were notified specifically that their employment was temporary, have been dismissed; but these dismissals have largely been offset by the return, during the same period, of many men now released from H.M. Forces and from other industries.

On May 16th, the rate of percentage levy was increased from 10 to 12½ per cent. for allocated workers and proportionately for weekly workers.

In spite of this, I am sorry to say that the resources of the Management Fund are already seriously depleted and, indeed, unless there is a very considerable improvement in the present position, the Management Fund will be expended long before the end of the year.

In view of the seriousness and urgency of this position, the Corporation yesterday called a Conference—which was extremely well attended—of both sides of the industry and representatives of the Ministry of Labour and the Ministry of Transport. After a full and somewhat lively discussion, which I think showed that all parties recognised the gravity of the situation, it was agreed that headquarter representatives of the Corporation and the National Joint Council and the Ministry of Transport should visit the major port areas to consider with local representatives—

(a) what is the Labour Force appropriate to the area;
(b) the action necessary to bring this about; and
(c) to advise the Corporation or the Ministry of Transport accordingly.

This survey is to be completed by July 20th.

This is a fact-finding survey; but at the same time the representatives of headquarters will be able to make known our views to the ports, to discuss the practical problems of the locality and, I hope, make recommendations that can be implemented thereafter. I am sure that you will give our representatives your fullest co-operation in this most important task.

Labour Requirements of the Industry

It has been said that "the truth is seldom pure and never simple." This is particularly true of an industry so subject to international trade influences, National policy and the vagaries of the weather all over the world. Nevertheless, in spite of these imponderables, it will be necessary in the future to estimate the Labour Force to be maintained to meet the normal needs of the industry in times of peace.

By that I mean that it must not be assumed there will be a fringe of unregistered labour waiting at the dock gates, or the Employment Exchange, for employment. The ports must be manned to meet normal requirements, and at times there may be temporary shortages.

I agree that there must be a marginal surplus of labour in this industry; but it ought to be kept to the minimum; what that margin should be is a matter for the industry to determine. Each man not gainfully employed costs the Corporation on average, at the rate of £180 per year. I am more concerned with social costs. We are, in fact, at present maintaining concealed unemployment which is wasteful of labour and bad for the individuals concerned. This is not a position to be continued; but the ultimate solution is not simple.

In very many ports, further cuts would mean dismissing established pre-war dockers, many of whom have served the industry faithfully all their lives. In the old days, the rewards

National Dock Labour Corporation—continued

were meagre; there was no security; and no continuity of employment. Normal recruitment has been negligible since 1919. This is reflected in our Labour Force of to-day, of which nearly 7% are over 65 years of age and more than 30% are over 55. But in this industry, age is only one factor to be considered in relation to a man's efficiency; although there are many who are now virtually past employment.

Blind cuts, without regard to quality and industrial obligations, will not solve the problem or, more important, build the Labour Force adequate for the future. To achieve this, entry to the industry must be regulated. Dock work is now attractive and a man must be expected to justify his place on the register.

There has been some considerable goodwill towards the idea of decasualisation for the last quarter-of-a-century; but every attempt of employers, men and the Government broke on the question of finance. That, perhaps, was inevitable when decasualisation costs were regarded as an additional charge in a competitive industry.

I sometimes think that it is perhaps forgotten that more than one-half of our percentage levy is required to meet industrial charges which would have to be borne by the industry whether or not there was a scheme for decasualisation.

It is not practicable or desirable to solve financial or other difficulties of the industry in terms of labour alone. Labour is not the only charge in this industry. There are other standing charges which are accepted without question. There are many uncertainties, which also involve cost. I am sure that modern ingenuity, foresight and co-operation can ease the effects of some of these and somewhat level out the peaks and troughs of employment.

National Port Policy

It will not have escaped your notice that the Government is considering the question of the future control and management of our ports. The ports are vital to every aspect of our economic life; indeed, in a country such as ours, in which no village is more than 70 miles from a tidal estuary, the efficiency of a port may well determine the economic life of the hinterland. Such an important fact of our National Economy cannot be subject to the caprice of local enterprise.

The ports must be maintained in a high state of efficiency, adequately equipped, with a well-designed rail and road system, and an adequate and efficient Labour Force—all of which involve legitimate standing charges as part of the operational costs.

In this connection I have recently read with very great interest the report of the South Wales and Monmouthshire Joint Ports Committees as to the difficulties confronting these ports since the war—and particularly since the closure of Diversion Room at the Ministry of War Transport. The report contains a significant and illuminating table of comparative port costs and comments that "the major trouble lies not so much in the total costs of loading goods at the ports, but in the division of those charges." I gather, there is no uniformity of practice as between port and port and that non-local interests sometimes influence materially the flow of trade as between the various competing ports.

This affects us all. In the ports suffering as a result of such competition, labour is redundant. To reduce the Labour Force below a certain minimum is to lower the efficiency of the port; to maintain a volume of men in idleness is too reminiscent of the period between the wars and is not to be considered.

If, as I think, it is in the national interest for peace and war that our ports should be efficiently maintained, it follows that available shipping and the flow of trade must be related to these ports as well as other relevant factors. Neither men nor machines improve in idleness. In my opinion, we cannot allow the well-being of our ports and the livelihood of some 100,000 men to depend upon what has been called the "free exercise of judgment in commercial enterprise." The "natural interplay of economic forces" must be harnessed to the best interests of the whole community.

New Approach Needed

Up to this point, I have tried to stress the need of relating our problem to over-riding first principles. I have suggested that, in some fields, a fresh line of approach is required by shipowners, importers, merchants and employers. Let there be no misunderstanding however; an equal change of outlook is required from the worker; he, too, must accept his obligations. If the employer is to modify his practices, it will be necessary, also, for the worker to modernise many of his practices and customs—some of which have come into being as a necessary and justifiable safeguard in the days of casual labour. I cannot do better, in this connection, than to quote the Prime Minister who said: "I ask my fellow Trade Unionists to look carefully to see whether there are not customs and rules established for the protection of the workers before the days of full employment which are to-day unnecessary and hampering to full production." And, I would add, he must give a fair day's work for a fair day's pay. Rights entail duties.

Men must be prepared to devise and to accept changed conditions and to recognise the new situation. This is not always easy; for example, the men in London have consistently refused to use the Call Stands—built for their benefit—to be engaged for work. At the London Enquiry in March, 1945, I sought to find the reason for this refusal—which, by the way, is peculiar to London—and was told by the men that to use the Call Stands "was loss of freedom" and the "loss of the rights fought for, and gained by their fathers in the past. There is obviously some mistrust and much misunderstanding in this attitude which originates in the days of casual employment. I am not condemning such a view. I can only marvel.

I use this illustration merely to show that the decasualisation of the docker and of the industry will be a long and steady process, perhaps not fully realised in one generation; old habits of thought and action die hard.

The National Strike

There was an incident in 1945 to which I would refer.

There was the National Strike, which, starting in a pit prop yard in Birkenhead, spread rapidly through most of the major ports of the country during October of last year. I am sufficiently well-versed in the affairs of working men to know that a movement of that magnitude, however organised, does not come into being without an underlying and deep sense of grievance. Something was wrong; I am not sure that the sense of grievance has disappeared or that the causes have been entirely removed; but with that aspect of the problem I am not, at the moment, concerned. The feature of the strike which disturbed me most profoundly was the unofficial organisation which, for a brief period, sought to dominate industrial negotiations.

If, as I hope, authority for maintaining discipline and perhaps other matters devolves in increasing measure upon the men, it must be clearly understood that authority carries with it the burden of responsibility. Those who seek to deny the authority they themselves have vested in their elected leaders, undermine the very structure of industrial negotiation.

I welcome a lively and active minority in so far as it contributes new and dynamic ideas to our society; but when such a minority is exploited and canalised into unofficial subversive channels, then I cannot but advise the men that they imperil the very social standards they seek to improve.

The Dock Workers (Regulation of Employment) Act will place increasing obligations upon employers and workers. I regret that the industry has not yet found it possible to devise its own schemes. I can only urge that this matter should not be left in abeyance too long, otherwise schemes will have to be prepared so quickly, in order to be operative in July of next year, that the careful weighing of past experience and consideration of future plans will bear the imprint of hasty decision. I may, perhaps, take this opportunity of saying that the extensive experience of the Corporation in operating these schemes is available to the industry and to the Minister, should it be required.

Welfare Policy

Sir Ronald Garrett said in his speech two years ago that the Corporation regards Welfare as "a characteristic of the right approach of each officer to his normal job and to the men's problem and," he continued, "all our plans are ultimately tested

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on the quayside when Corporation officers and men meet at the Calls." That I believe to be profoundly true; it has been the basis of our welfare work which, by the men's own momentum, has improved in quality and steadily increased in volume. There has been a remarkable and varied growth of activities, the most encouraging feature of which has been the willingness and anxiety of the men to organise and administer their own schemes. This is in full accord with the policy and practice of the Corporation, but is only a beginning; it is exploratory field work. It includes the supply of safety boots, the organising of sporting events, flower and vegetable shows, educational film shows, talks and discussions, library facilities and Benevolent Schemes and Dockers' Clubs. Our experience to date, I think, helps to clarify our approach to welfare. We have no intention of undertaking or financing work appropriate to Statutory and Voluntary bodies. But we would always be ready to co-operate with them in devising schemes, such as Port Medical Services, and to accept our share of the obligations within such schemes. It may even be that it will fall to the Corporation to initiate and plan these developments in the first instance and, to borrow Sir Ronald's phrase, " be the activating agent."

But this is only one aspect of Welfare. There are many efforts of the men which cannot come to full fruition without some outside help. In my view, therefore, the Corporation, as Trustees for a considerable sum of money, will need to declare its policy and indicate the type of scheme which may be submitted by men and employers for help from the Corporation. Our aid may range from agreeing to collect weekly voluntary deductions for local Benevolent Schemes to the provision of Port Medical Centres.

However that may be, I am sure that our underlying principle must be that whatever we do now shall be so founded as to ensure a long-term Welfare policy. My Board regret the delay that has been occasioned through difficulties beyond its control in implementing our intentions earlier. However, it is to be hoped that we may now proceed, with the concurrence of the industry, to make Welfare provision for our workers among the best in this country.

Staff

It is with a deep sense of gratitude that I refer to my staff. From the General Manager downward, I may say that, not only have we a staff of loyal workers, but they believe in the Cause they serve. That, Gentlemen, is an asset not to be measured in terms of money. I have travelled this country during the past year and seen your Port Officers at work. Everywhere, I have been impressed by the team spirit among our staff. They believe, as I am sure you do, that the work on which they are engaged is of more than local importance. What they do in this country will be, and indeed is being, watched closely wherever men follow ships.

Obituary

The announcement of the death on July 2nd last, of **Mr. Asa Binns, M.Inst.C.E., M.I.Mech.E.,** has caused widespread regret in the engineering profession, particularly in port and harbour circles.

The late Mr. ASA BINNS.

Born at Keighley, Yorkshire, on 3rd October, 1873, Mr. Binns was educated at the local Grammar School and in 1891 entered Yorkshire College, Leeds (now Leeds University). He served his apprenticeship with Messrs. Tannett, Walker & Co., Hydraulic Engineers, Leeds, from 1893 to 1896, and in the latter year after gaining a Whitworth Exhibition, he was appointed draughtsman with Messrs. Ransomes, Sims & Jefferies, and held the position until 1897. Following a year on the staff of the North Eastern Railway at Hull Docks, he entered the Civil Engineering Department of the Admiralty and gained rapid promotion until he attained the position of Assistant Civil Engineer.

In 1906, he was engaged by the London and India Docks Company and became resident engineer at the London and St. Katherine Docks, and on the formation of the Port of London Authority in 1909, he was transferred to a similar position at the Surrey Commercial Docks. In 1912, he was appointed resident engineer in charge of the south extension works of the Royal Albert Dock system, subsequently known as the King George V Dock, which was opened in 1921. In 1928 he was appointed Chief Engineer of the Port of London Authority and after his retirement in 1938, continued to be at its disposal in a consultative capacity in association with Messrs. Rendel, Palmer & Tritton, Consulting Engineers, Westminster.

Many new works were completed or initiated by Mr. Binns during his term of service with the Port of London Authority, among them being not only the aforesaid construction of King George V Dock, a detailed account of which was given by him in a Paper read before the Institution of Civil Engineers in 1923, but also the new entrance and passenger landing stage at Tilbury, the widening of over a mile of quay at the Royal Albert Dock with the deepening of berths alongside to 34-ft. and the modernisation of the Royal Victoria Dock.

Mr. Binns was a member of long standing of the Institutions of Civil Engineers and Mechanical Engineers, being President of the latter in 1940-41. He was also President of the Institution of Engineers-in-Charge in 1936-37. He was to have succeeded to the Presidency of the Institution of Civil Engineers for the current 1946-7 session. He served for a number of years in the Territorial Army, attaining the rank of Lt.-Col. in the Royal Engineers.

Unloading Record on the Tyne.

A record has been established in the unloading of a cargo of iron ore from the Swedish ship "Rantas" at Tyne Dock. The vessel brought 11,500 tons to the river, this being discharged at the rate of 400 tons an hour. Eight cranes, each dealing with 50 tons an hour, were used, and it is understood that this was the first time eight cranes were used simultaneously on one vessel on the Tyne.

Notes of the Month

Suggested Free Port for Great Britain.

In the House of Commons recently the Chancellor of the Exchequer was asked what enquiries are being made as to the advantages of a Free Port in Great Britain, and in reply, Mr. Dalton said he was looking into the question in consultation with the President of the Board of Trade and the Minister of Transport.

Lock at Ymuiden Repaired.

The large lock at Ymuiden which was damaged by the Germans during their occupation of Holland has been so far repaired that liners are now able to pass through it. The lock gates are being worked by electric winches for the time being, until the whole of the machinery is repaired. All vessels, except a few of the largest, are now able to proceed to Amsterdam.

Proposed Reconstruction of Mallaig Harbour.

Plans for the reconstruction of Mallaig Harbour were discussed at a recent meeting of representatives of the L.N.E.R. Company, Inverness County Council, and the Mallaig Development Council. The plans provide for increased shipping accommodation and adequate shelter for fishing vessels. It was stated that a new fishing company has been formed, and it is expected their boats will be operating from the port in the latter part of this year.

Reconstruction at the Port of Rangoon.

Work on the restoration of facilities at the Port of Rangoon, which was badly damaged by bombing and demolitions, is expected to be completed early next year. Rapid progress is being made in the repair of workshops, buildings and slipways, and new plant and machinery is being installed. One of the main wharves has been cleared of obstructions and can now work to full capacity. Underwater wreckage which is hampering the free use of other berths and slipways is being cleared by divers and salvage experts.

New Appointment for Tyne Dock Official.

Mr. C. P. B. Goldson, resident engineer at the Albert Edward Dock, North Shields, is leaving the service of the Tyne Improvement Commission to take up a post as resident engineer with the Port of Bristol Authority He was appointed resident engineer at the North Shields dock in March, 1939, and during the war served with the Royal Artillery attaining the rank of major. He returned to his position with the Tyne Improvement Commission on demobilisation.

Navigational Aid for Bay of Fundy Run.

Tests were made recently of the electronic device which has been placed in the Canadian Pacific steamship "Princess Helene" to increase the safety of the Bay of Fundy run between St. John and Digby, Nova Scotia, in poor visibility. Buoys were identified from a distance of 2,500 yds., and in the middle of the bay the shorelines of both Nova Scotia and New Brunswick showed on the set's scan, which has been designed to show objects in the water at ranges from 150 yds. to 45,000 yds., or 27½ miles. The set was designed by the National Research Council as a navigational aid for merchant ships.

Repairs at Tilbury Dock.

The Minister of Transport was recently asked in Parliament what plans he has for the modernisation and improvement of Tilbury Docks with special reference to loading, unloading and ship-repairing facilities. In reply Mr. Barnes stated that plans for the modernisation and improvement of Tilbury Dock are under consideration by the Port of London Authority. They include the provision of improved road access which is under discussion with the Government. At present the Authority are concentrating upon the repair and re-instatement of transit shed accommodation, which suffered considerable damage as a result of enemy action, and the repairs to three transit sheds at Tilbury Docks have already been completed. Modernisation and improvement of ship repairing facilities are matters for the firms concerned.

Bristol Pilotage.

The Bristol Pilotage Committee has recommended to the City Council that the temporary wartime measures for compulsory dock pilotage at Avonmouth and Portishead shall be adopted permanently and that for greater facility all docks shall be excluded from the pilotage district but not entrance basins and locks leading to them.

Oil Storage Facilities at Blyth.

Proposals are under consideration for the setting up of oil storage tanks at Blyth on a site near the import dock. An oil distribution firm has made preliminary inquiries and is in touch with the Blyth Harbour Commissioners. It is understood a site of 40 acres will be needed and, if the plan materialises, suitable berths will have to be provided for ships.

Trieste Port Traffic.

According to statistics issued in Trieste, traffic passing through the port during the first four months of 1946 totalled 580,000 tons, representing 54.3 per cent. of the figures for the corresponding period of 1938. Nearly all this traffic consisted of goods arriving by sea, only about 11,200 tons being exports, as communications with central European countries through Trieste are not yet adequately restored. Over 150,000 tons of relief supplies for Yugo-Slavia were included in the imports figures.

Dry Dock Proposed for Dundee.

Dundee Harbour Trustees have instructed their Development Committee to deal with a suggestion by Mr. Henry Main, managing director of the Caledon Shipbuilding and Engineering Company, Ltd., that the question of a new dry dock for Dundee should be brought before the Government's recently appointed Shipbuilding Advisory Committee, who will be asked to recommend that the Government should grant substantial financial assistance in building a dry dock such as is proposed.

Grant for Wick Harbour Repairs.

The Wick Harbour Trustees have been informed by the Treasury that on recommendations from the Scottish Home Department, they are to receive grants for harbour repairs amounting to over £50,000. The first grant is for £44,280 and will defray the cost of reconditioning and repairing the harbour. The two largest items in the programme are steel piling and concrete works at the north retaining wall in Martha Terrace at a cost of £15,250, and underpinning and provision of a new concrete apron on the seaward side of the South River pier at a cost of £14,980. The second grant, amounting to £6,465, is to provide plant which will be leased to the Trust. A letter from the Treasury states that the Development Commissioners are satisfied that the works are urgently required for the preservation of the fabric of the harbour and that the Trustees are unable to make any financial contribution.

Extensions at the Port of Buenaventura.

A contract has been signed by the Colombian National Railways and the Raymond Concrete Pile Company, U.S.A., for the extension of the mole at Buenaventura. The contract covers extension of 322 lineal metres of the mole; construction of two warehouses, each double the capacity of the existing ones; the pavement of new yards, totalling an area of 28,000 sq. metres; the construction of a new air port; the dredging and filling in of 250,000 cu. metres, and other additional works. Operations will commence immediately, and the contract is expected to be completed in 15 months. The contractors will also undertake surveys for the removal of the present railway station and the conversion of the railway yards into paved roads for motor vehicles, thus affording easy access to the Customs warehouses and facilties for cargo to be transported by road from Buenaventura to the interior. Once the work is completed it should prove highly beneficial to the handling of cargo at Buenaventura and greatly alleviate congestion.

The Future of Inland Waterways

Problems of Operation and Maintenance*

The inland waterways of the British Isles can be grouped in four main categories:—

(1) Rapid rivers and streams not suitable for commercial navigation.

(2) Large, slow-flowing rivers which, with the assistance of locks and/or tidal influence, are suitable for commercial navigation (e.g., Rivers Thames, Severn and Trent).

(3) Artificial still water canals constructed solely for the purpose of commercial navigation and including (a) ship canals navigable by seagoing vessels (e.g., Manchester Ship Canal, Gloucester and Berkeley Canal); (b) Narrow Boat or Barge Canals where size of locks, headroom, width and draught restricts commercial navigation to vessels unsuitable for open sea work. The majority of inland waterways in the British Isles come within this last classification.

(4) Waterways combining the characteristics of (2) and (3) above, that is to say rivers made available for commercial navigation by the construction of considerable canalised cuts (e.g., River Kennet, Berkshire; River Soar, Leicestershire).

In the Fen districts of Eastern England there are examples of types (2) and (4) where the primary motive for the construction of locks, sluices and cuts has been that of land drainage, and where commercial navigation has been regarded as a secondary amenity. The present reconstruction work proceeding on the River Nene is an example of this type.

With the exception of these drainage works, and of the waterways in category (1) the whole system of inland waterways developed in response to the need for inland transport facilities in days when overland communication was largely confined to the pack-horse. Some understanding of that development is therefore necessary before the modern planner can effectively consider inland waterways either as a means of transport or in their wider aspect as a part of the problem of land drainage, water conservation and water use.

Historical Background

In mediæval times, inland navigation was largely confined to the larger rivers of category (2). Locks were unknown in the British Isles and navigation was subject to frequent interruption by drought or flood. Because of the absence of weirs and locks, these larger rivers were tidal far inland and craft proceeded inland stage by stage on successive tides. In the upper reaches above tidal influence, temporary dams of brushwood and turf were sometimes thrown across the river to increase the draft and enable vessels to proceed upstream, the dams being broken down when the vessels returned. These primitive dams were superseded by permanent weirs having a removeable portion or gate to allow the passage of craft. A few of these "Navigation Weirs" survive in use to the present day, e.g., on the Warwickshire Avon at Pershore and Cropthorne. These weirs took a greal deal of time to negotiate, and wasted a great deal of water for each vessel passing through. The lock naturally superseded them, being in effect a double weir enclosing a short equalising pound of water between.

Because of the fall available, mills were established in the vicinity of practically all the early river weirs and locks, and in this way there arose an acute conflict over the use of water between mill operators and navigators. The growth of trade during the 17th and early 18th century aggravated this conflict, for not only were local sources of water-power exploited to the utmost, but a number of canalised river navigations category (4), were constructed. It was only resolved by the introduction of steam power and of still water canals.

James Brindley, the first great English canal engineer, was a tireless advocate of still water canals as opposed to river or canalised river navigations. He not only argued that the former were less liable to interruption by drought or flood, but that the advantage which downstream river traffic derived from the current was more than offset by the increased power required by upstream traffic. These arguments remain valid to-day, provided the canal possesses an adequate water supply. The only advantage of the river navigation over the canal is that it is less liable to icing in winter.

It is important, when considering a map of the English canal system, to remember that in the days when the system was evolved our industrialised and consequently centralised economy was still in embryo, and therefore trade routes tended to conform to an older regional framework. Not only were canals built to serve regional needs which then existed, but their dimensions, i.e., size of locks, were often adapted to suit the traditional type of craft used on local rivers. For example, whereas the Midland canal system as a whole is adapted to the use of standard canal "Narrow Boat" or "Monkey Boat," 70-ft. long by 7-ft. beam, locking singly on "narrow" canals or in pairs on "broad" canals, the range of this type of craft does not extend to the fenlands or to Yorkshire where the locks were built to suit the shorter but broader beamed Fen Lighters or Yorkshire Keels.

The canal companies originally confined their activities to the maintenance of their waterways, charging tolls for their use; they seldom or never acted as carriers. Traffic was handled by a great number of small carriers or "by traders," many consisting of working owners of one or two boats. The canal company carrying on its own account and the large company with a fleet of boats are latter-day developments. They first evolved under the stress of competition from railways—a form of transport which automatically eliminated "by trade" on its own system.

With the coming of the railway era many canal companies, fearing their new competitor, agreed to withdraw their opposition to the railway promoters on condition that the latter bought them out, often at extravagant prices. In this way a considerable canal mileage passed into railway ownership with disastrous results, despite the fact that the railways were bound by statute to maintain in navigable condition the canals they acquired. This was inevitable if we realise that the railways acquired canals which were not only over-capitalised, but which frequently formed links in through water routes which competed directly with their own rail routes. It is hardly surprising, therefore, that the railways conformed to the letter but not the spirit of their obligations. While locks and other above water works were maintained, no improvements were effected and dredging, the most important task of effective canal maintenance, was generally neglected. Furthermore, the interposition of railway controlled sections in through water routes prevented adequate co-operation between the remaining independent canal companies with regard to through working and toll charges. Had it not been for this an organisation similar to the Railway Clearing House might have been established. Railway obstructionism took more tangible shape when steam-powered craft were introduced, a move which was countered by banning power-driven craft from a number of railway-controlled waterways.

Survey of Present Position

To-day many of our waterways have fallen into complete or partial disuse. This is due partly to the effect of the railway control above-mentioned and partly to road transport competition which has set both canal and rail transport at a disadvantage because, unlike the latter, the track used by the road haulier is maintained by the public. A third and most important factor accounting for the decay of canals is the fact that large scale industrialism, with all the concentration which it involves, has radically altered the "trade map" of this country with the result that the course of many of the canals no longer corresponds with modern trade routes.

Consequently, with the exception of traffic in the North of England in and between the areas of industrial Lancashire and Yorkshire, water-borne trade is largely confined to the waterways forming what has been called "The Cross." The complex system of waterways around Birmingham and the Black Country

* A Report (slightly abridged) prepared by Mr. L. T. C. Rolt for the Association for Planning and Regional Reconstruction.

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form the centre of the Cross and from it the water roads radiate to the four great rivers, Mersey, Trent, Thames and Severn. Some of these arms are represented by more than one route, while the Leicester Section of the Grand Union Canal affords a direct link between London and the Trent near Nottingham. The passing of the Thames and Severn Canal early in this century broke the shortest link between these rivers, while the railway-controlled Kennet and Avon Canal which links the Thames at Reading with Bristol, though theoretically navigable, has been disused by trading boats for many years. The present tendency is to concentrate on the waterways forming the Cross, and to "lop off" what might be described as the branch and cross-country lines. Even these waterways which continue in regular use, whether controlled by railways or by independent companies, are seldom maintained to a degree of efficiency comparable to that which they enjoyed when they were first constructed. This is due mainly to two reasons: the lack of adequate dredging and water supplies. This will be considered in subsequent paragraphs.

approximately 2 m.p.h. loaded and 3 m.p.h. empty, while that of the motor craft is 3 and 4 m.p.h. respectively. On waterways of categories (2) and (4) where river current has to be considered the motor boat is at a greater advantage, being better able to proceed against the current and more readily controllable when travelling downstream. Where horse-drawn craft make use of rivers it is now customary to put them in charge of motor tug boats (e.g., River Severn). On still water canals of category (3) the motor has superseded the horse boat not so much from the point of view of speed, but for the following reasons:—

(1) The ability of the motor boat to travel "fly"—that is day and night without the need for the relay of horses necessary for such working in pre-motor days.

(2) The inability of horse boats to traverse tunnels (the majority of which lack a towing path) without having resort to the old system of "legging," by which the boatman propelled the boat by pushing with his feet against the tunnel walls, or the maintenance of a regular service of tug boats.

(3) The lack of labour able to handle horses efficiently.

(4) The decay of canal-side stabling facilities.

View of Lock and Sluice from upstream at Dog-in-a-Doublet, River Nene Navigation

Methods of Operation

The great bulk of canal traffic to-day is handled by the "Narrow Boat" or "Monkey Boat," 70-ft. long by 7-ft. beam. These craft are sometimes of wood and sometimes of steel construction. There are slight regional differences in construction and carrying capacity, but the average loading is 25 tons for a motor-driven boat and 30 tons for a horse-drawn or towed "butty" boat. The unit commonly in use for long-distance haulage consists of two boats, a motor boat and towed butty. These are frequently operated by a family, the two boat cabins forming the living quarters. There are now very few owner-boatmen, the majority being employees of (a) Canal Companies carrying on their own account, (b) Canal Carrying Companies, (c) firms operating their own boats to convey their raw materials, manufactures, or goods which they merchandise.

In the case of canals having wide locks, e.g., the Grand Union Canal from London to Birmingham, these travelling pairs of boats lock through together, side by side, but on narrow canals they must lock singly. This involves more time and also man-handling the butty boat. In some cases single motor boats are operated on these waterways, while in certain instances where a flight of narrow locks handles considerable traffic, horses are available to work the butties through the flight. Horse-drawn craft have now become rare for long-distance work, though they are widely used for short hauls in the Black Country area, the boats used for this work being known as "Day Boats" because they carry no sleeping accommodation. The difference in speed between the horse-drawn and motor-driven narrow boat in still water is approximately 1 m.p.h., the speed of a horse-drawn craft being

As against this the motor boat possesses one great disadvantage compared with horse boats for canal work, which is that propeller wash causes considerable bank erosion. The effect of this is so great that if the need for constant dredging is to be avoided, a canal passing a considerable volume of motor-driven traffic requires bank reinforcement. A considerable length of the Grand Union canal banks have been reinforced with pre-cast concrete piling for this reason.

It has often been argued that our canals should be adapted to admit larger craft by rebuilding the locks. This is not simply a question of enlarging locks, however, but would involve the costly enlargement of the whole waterway. The speed of a craft on an inland waterway is not solely governed by the potential of the craft itself in open water, but by the ratio between the cross-section of the waterway and the cross-section of the craft. The more closely these two conform to each other, the slower the speed, because the water will be unable to pass the hull but will tend to pile up before the bows of the boat, creating in the process a breaking wave causing much damage to banks. For example, the Grand Union Canal from London to Birmingham is theoretically capable of passing craft of 12 or 14-ft. beam, but in practice it is found that it is better to handle the same cargo in two boats of 7-ft. beam travelling in line astern. Not only do the narrow boats travel better, but they are capable of working through on to canals with narrow locks. Apart from certain short

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distance exceptions, therefore, wide boats and barges are largely confined to rivers and ship canals where the width and depth of channel available is much greater.

While the canal narrow boat is not seaworthy, the motor-driven narrow boat is capable of entering tidal reaches of rivers, so that direct transhipment from ocean-going to canal-going craft is nearly always practicable. Without the radical reconstruction of our inland waterway system it is very doubtful whether the present type of craft in use could be superseded. The suggestion of utilising the amphibious craft developed by war needs is hardly practicable for reasons which should already be evident, while the practice of towing trains of dumb barges behind a tug is not feasible on the majority of our canals where considerable lockage is involved. On certain lock-free waterways such as the River Severn or the Aire and Calder, the system is already in use. This rules out the application of electric traction via overhead pick-up which is only practicable where the tug system can be utilised on a large scale as in Italy.

At the present time a considerable volume of long-distance canal traffic loads only in one direction. This involves a great expenditure of man-hours, water and fuel in working empty boats. The conclusions to be drawn from this will be considered later.

Principles of Waterway Construction, Water Supply and Maintenance

In the case of navigable rivers and canalised rivers, water supply consists of the river itself or its tributaries. Owing to the scouring action of the current, and the width of channel, bank erosion by river traffic is negligible, and the necessity for dredging is mainly confined to the lower reaches. Here water-borne silt, the result of natural bank erosion, particularly in time of flood, is deposited. Our major rivers are now generally in charge of public bodies such as the Severn Commissioners or the Thames Conservancy Board, whose primary concern to-day is with land drainage within the catchment area rather than with river navigation. In recent years the aim of some of these bodies appears to have been that of getting rid of surplus water as expeditiously as possible, and there has been little attempt to utilise or conserve it. To achieve this end the beds of tributary streams and rivers category (1), have been deepened by dredging and banks have been cleared of vegetation to increase the current rate by making an unimpeded flow. This has certainly reduced flooding but is a short-sighted policy of expediency for the following reasons: The value and fertility of the water meadows in the vicinity of these rivers and their tributaries was largely dependent on their periodic flooding. Where such flooding has been eliminated by unduly deepening river channels or by lowering the water table by excessive pumping, the agricultural value of these water meadows has been greatly reduced.

The aim should be to control and not to eliminate flooding, and in this respect the example of the past is worthy of notice. The traces of the leats cut by the Cistercian monks of Buildwas in the Severnside meadows demonstrate this idea of control by revealing that they were designed to serve the dual purpose of drainage and irrigation. Looked at in a wider aspect, the risk of excessive flooding in the greater river basins has probably increased in recent years because, owing to the loss of moisture retaining humus in the soil occasioned by the substitution of artificial for organic manures, there is a much greater and more rapid "run off" than heretofore. Finally, the principle of clearing river banks of vegetation to obtain more rapid flow is disastrous and ultimately defeats its own object. When there is no vegetation to hold the banks, bank erosion is greatly accelerated; consequently the rate of silt deposition near the river mouth is increased, and unless this is kept in check by constant dredging the tendency to flood will be greater instead of less.

From the point of view of river navigation, the main item of upkeep is that of the locks which are prone to damage if excessive flooding takes place. In the case of the major rivers category (2), the locks are generally maintained by the public controlling authority. In other cases, particularly that of the canalised rivers, category (4), responsibility is divided. Sometimes different local bodies are responsible for different reaches of the river, including locks or weirs, and sometimes the river itself may be the responsibility of one or more local bodies while the navigation of the river, including the repair and maintenance of locks may be the responsibility of the company owning the canal system of which the river navigation forms a part. There have even been cases where the river towing path was owned and controlled by yet another authority. Owing to the introduction of motor craft, or to the disappearance of water-borne trade, the greater part of these river towing paths are no longer used for their original purpose. In many cases they are still available for use by fishermen, holiday-makers or local inhabitants, but in others they have been rendered impassible by local property owners enclosing down to the river bank. The argument usually advanced in support of such enclosure is that right of way only existed for those using the path for its original purpose, i.e., the haulage of boats.

The supply of water to still water canals, category (3), is much more complex. On their lower levels, where they may run parallel to, or on a level with rivers or streams, they may draw additional supplies readily, but their main source of supply must be their summit level. Each boat which passes through such a canal draws two locks of water away from the summit, one as it ascends and another as it descends. A wide lock consumes 56,000 gallons and a narrow lock 25,000 gallons, average figures. Ascending, the boat will draw off this quantity at each successive lock till the summit is reached so that, assuming locks of equal depth and no wastage, it will leave each level as it found it. Similarly, when descending, it will carry one lock volume of water down the locks with it. A point not generally realised is that the quantity of water used in lockage varies according to whether the boat is loaded or empty due to the displacement factor. Thus a boat locking up uses a lock of water plus the amount it displaces, but in locking down it uses a lock full *less* the amount displaced Hence the fact that a loaded boat consumes more water than an empty one when locking up, but the empty boat uses more than the loaded when locking down. To overcome such inequalities, and to offset the effects of leakages or the variable depth of locks a weir is provided by each lock with the object of equalising the levels in the different pounds. These weirs also allow the passage of flood water after excessive rainfall.

The principal water supply of a canal must therefore be drawn from its summit level which is frequently situated on a water shed at a height usually above the 400-ft. contour. This involves drawing supplies from the widest practicable catchment area, and the provision of adequate storage capacity to tide over periods of summer drought. Nearly all our canals are supplied by one or more reservoirs on their summit levels, while in some cases a long summit level of canal itself represents additional storage capacity. These reservoirs may be supplied by natural streams or springs, by artificial surface feeders or by pumping from deep springs or artesian wells or by combination of all three methods. In this way the canal system is very closely linked with the drainage and water supply system of large areas. It represents an elaborate mechanism of water conservation in precisely those areas most susceptible to drought.

In some cases the branch of a main line of canal may have been built for a dual purpose as a navigable feeder, connecting the main line with the head waters of some considerable stream. An example of this is the Llangollen Branch of the Shropshire Union Canal which extends in the form of a navigable feeder from Llangollen to the Horseshoe Falls where it draws water directly from the River Dee.

Numerous devices have been evolved to economise the water used in lockage. These may be enumerated as follows:—

(a) Waiting Turns.—Where one boat follows directly behind another a lock of water will be wasted because the following boat will have to run off the lock just vacated by the leader before it can enter. The most economical use of water is secured if a boat moving up a flight of locks is next succeeded by a boat travelling in the opposite direction. The principle of waiting turns regulated traffic in this way and has sometimes been

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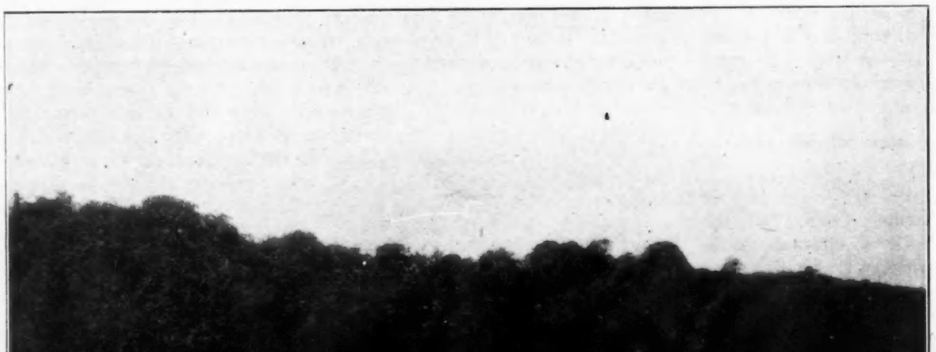
enforced in time of drought. It leads to considerable delay unless traffic is heavy and regular.

(b) Side Ponds.—These consist of small reservoirs built beside each lock at a level midway between that of the upper and lower pounds and connected to the lock by means of a "paddle" or sluice. A descending boat entering a full lock first discharges the water from the lock into the side pond until lock and side pond levels equalise with the lock half empty. The side pond paddle is then closed, and the remainder of the water in the lock is discharged into the canal below in the ordinary way. Similarly, an ascending boat entering the empty lock first half fills the lock from the side pond before drawing the remainder from the canal above. In each case half a lock of water is saved. Many of the locks on the Grand Union Canal employ this system.



Timber Barges on River Severn

(c) Paired Locks.—In this case duplicate locks, side by side, employ the principle described above, one acting as a side pond to the other by means of an inter-connecting sluice at midway level. The twin narrow locks between Harecastle and Middlewich on the Trent and Mersey Canal are examples of this method.

(d) Pumping Back.—The installation of pumping units at each lock or compact flight of locks which return lockage water from the lower to the higher levels. Such pumps have been installed on the Grand Union Canal and have been used in time of drought.

The water shortage on canals has been aggravated in recent years for a variety of reasons, chiefly:—

(a) Sources of supply diverted or tapped by other users, i.e., pumping for domestic or industrial use. For example, the establishment of a pumping station by the G.W.R. near Kemble to supply their Swindon works was the main reason for the closing of the Thames and Severn Canal because it tapped the springs upon which the canal depended;

(b) The silting up of feeders and reservoirs due to the neglect or impoverishment of the railway or canal companies responsible; also leakage from canal summit levels through banks or locks for the same reasons;

(c) Rapid rainfall run-off due to soil impoverishment with the result that the water table is further lowered, and the rainfall does not replenish the springs from which water for the reservoirs is pumped.

It will be apparent that it is not practicable to stimulate a considerable increase in the volume of traffic over a particular canal without first ascertaining whether the water supply would be adequate to cope with the increased consumption.

The case for substituting lifts for locks has often been argued as a means of saving water and of speeding up traffic. Only one lift is in operation in this country though a number have been tried in the past. Compared with the lock, first cost of the lift is high, as is also the cost of the earthworks necessary on the course of the canal itself in order to secure a sufficiently great vertical difference of level to justify the use of a lift. Furthermore, whereas the vast majority of locks are worked by boat crews and so have no regular attendant, the lift would not only require more than one man in constant charge, but also the application of steam, hydraulic or electric power. Except where the change of level is naturally very steep and the traffic dense and regular, the use of lifts in place of locks is not justified.

Maintenance of the orthodox type of canal lock is chiefly confined to the following work:—

(a) Occasional lifting, examination and re-bedding of lock gates;

(b) Making good occasional damage to gates caused by traffic;

(c) Renewal of gates. The average life of an oak lock gate is approximately 20-25 years. Cast iron gates have been used, but they employ wooden mitre posts which require renewal, while their greater weight is a disadvantage;

(d) Repair and re-pointing of the masonry of lock walls. The need for this is chiefly occasioned by the action of frost in the ground behind the lock wall copings. This tends to thrust the copings inward, and they must then be jacked back and re-set.

These repairs involve closing the canal to traffic and are usually carried out during public holidays in the summer months, or on one day in each week.

By far the most important aspect of canal maintenance is the work of dredging. Owing to neglect and impoverishment coupled with the increased need for dredging owing to the use of motor craft, practically the whole of our canal system is suffering more from lack of dredging than from any other cause. This state of affairs has been aggravated during the war years owing to increased motor boat traffic on the one hand and lack of labour for dredging on the other. As a result, on many parts of the system, boats can no longer carry their full pay load. At the same time a vicious circle is created, for the restriction of the waterway with mud increases the wash set up by motor boats, so that the rate of bank erosion and consequently further silting up is increased. Many canals which once used steam dredgers have disposed of them owing to impoverishment when renewals were required and now rely solely upon manually operated "spoon" type dredgers. The capacity of these is so small that they are incapable of carrying out extensive work and their activities are confined to improving particularly bad sections which might otherwise make the canal impassable for loaded boats. The re-introduction of floating steam dredgers or the use of small dragline excavators operating from the banks, where the terrain permitted, would rapidly improve this state of affairs, while bank reinforcement would largely prevent its recurrence.

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Apart from locks and dredging, the main items of canal maintenance which remain are the repair of above water works such as tunnels, aqueducts, bridges, lock cottages, etc., the upkeep of the towing path, hedges, etc., and ice-breaking in winter. Bridges probably constitute the major item owing to the increasing weight of traffic passing over them. Two-paths on canals which no longer carry horse-drawn traffic are often neglected, sometimes washed away by bank erosion, and sometimes overgrown except where they are used as a local footpath or by members of boat crews going ahead to set locks. A canal towing path is not a public right of way. In cases where the path is used and maintained, foot traffic is commonly freely admitted, but the company concerned either forbid or levy a small toll on cyclists.

Freezing in winter is perhaps the most serious impediment to canal traffic. Given a suitable ice-breaker boat, a level pound of canal can be opened up fairly readily except in extreme frost, but ice makes lockage either very slow or quite impracticable. Broken ice prevents gates from opening or closing, and causes boats to get jammed between the lock walls. To offset this icing difficulty it is only fair to point out that the inland waterway is the only form of transport which is substantially unaffected by snow or fog.

Abandoned Canals

As a result of the factors already outlined a considerable portion of our inland waterway system has been abandoned, part of it many years ago, and part recently. In the case of navigable rivers and canalised rivers this has meant that the locks have fallen to ruin and that the reaches between locks are in many cases no longer of navigable depth. Nevertheless, the restoration of such a waterway to navigable use does not present an insuperable task with modern facilities. Even in cases where such a waterway would appear to have no immediate value for trading purposes, the value or improvement of the waterway as a public amenity for pleasure craft and for purposes of water conservation and crop irrigation should not be overlooked when restoration is considered.

Still water canals which have been abandoned for many years consist as a rule of disconnected lengths of dry and overgrown ditches interrupted by sections which have been filled in and frequently built over. Their restoration as a continuous waterway for commercial or pleasure purposes is generally impracticable. Possible uses for short sections of them will be considered later.

Still water canals recently abandoned survive throughout their length, and the pounds usually contain water but at a reduced level. The abandoning authority usually has to comply with the stipulations of local authorities for the areas through which the canal passes, or in some cases the local authorities assume certain responsibilities. These stipulations and responsibilities govern canal-owned property, local water rights, disposal and drainage, and the upkeep of bridges. Locks and other means for maintaining the waterway in navigable order are positively abandoned. When a canal is thus closed to traffic, weed growth soon makes the passage of screw-propelled boats impossible during the summer months irrespective of whether there is sufficient depth of water or not. These weeds have the effect of still further reducing the available draft. Again, unless some arrangement is made to secure a slow flow of water through the canal to compensate for the disuse of the locks, the water becomes completely stagnant and consequently unhealthy. To quote an example; in recent years a canal company abandoned a length of canal, built brick dams at each lock, and then removed the lock gates. The dead water between the dams soon became a breeding ground for a virulent breed of mosquito. After a number of people had contracted a mild form of malaria, the local council complained to the company who were compelled to spray the canal with tar oil and alter the dams to allow a continual flow.

Another point to be considered is whether the canal abandoned, or subject to abandonment is responsible for feeding another waterway still commercially valuable. Lacking the provision of proper safeguards, abandonment of the one may in time seriously injure the other. The Llangollen Branch of the Shropshire Union Canal, for instance, acts as a feeder to the Shropshire Union main line. The owning Company (L.M. & S. Rly.) obtained powers to abandon this branch last year. Unless this question of water supply has been adequately protected, the main line (which they also control) may eventually be starved and traffic impeded or suspended. The experience of the past tends to show that where the major obligation of maintaining a waterway in navigable order has been abrogated, the minor obligations tend in time to become "dead letters."

There are instances where a canal, passing through a river valley, is so intimately involved in the whole drainage system of the valley that its abandonment is a difficult matter. This is true of the Kennet valley section of the Kennet and Avon Canal, and it was largely for this reason that the G.W.R., as owners of the canal, were refused powers of abandonment when they sought them about fifteen years ago. To overcome this difficulty it has been suggested that the locks should be abandoned and weirs and sluices substituted. This is a case where, even if it can be conclusively shown that a trunk waterway with wide locks from London to Bristol is of no commercial use, the retention of the locks for pleasure traffic should be advocated as the course of the canal is of great natural beauty. Even failing the maintenance of locks, punt rollers should be provided at each weir.

Conclusions and Recommendations

When unlimited supplies of petrol once more become available it is apparent that the problem of congestion on our road system will become even more acute than it was in 1939. One of the most obvious means of alleviating such congestion is to transfer much goods traffic from the roads on to the railways and canals, confining road goods traffic as far as possible to rail head and canal head distribution. Besides causing much road congestion, the heavy road vehicle has caused and will cause much damage to the fabric of buildings in the towns and villages flanking trunk road routes.

For the conveyance of minerals in bulk, coal, roadstone, sand, etc., canal transport is eminently suited. It is also suited to the conveyance of fragile cargoes in bulk such as pottery and glass ware. The uneconomic empty boat working mentioned previously is largely the fruit of transport monopolies and competition. The principal logical flow of canal traffic in this country is from the Midlands to the south with coal or other manufactured goods, returning with imports transhipped at the ports of London in the east and Sharpness in the west. Other possibilities of two-way loading in other directions may readily be conceived. In an age obsessed with speed and size, the slow speed and small size of our canal boats is commonly criticised. Except where the need exists to transport a highly perishable cargo over a long distance, the first criticism is scarcely valid. For example, if it is required to perform a regular haul of X tons per week from A to B, the ability to do so by canal is simply a question of keeping the requisite number of boats in circuit. Even from the point of view of the actual time taken in transit, the canal is, or could easily be, quicker than the rail in handling a bulk cargo. For example, assuming a 55-ton cargo at London docks for shipment to a Midland factory or a simliar load of coal at a Midland colliery for delivery to a coal merchant in the south, a pair of canal boats will take the load and proceed directly to the nearest canal head, whereas the five or six railway wagons required for the same load will probably be re-marshalled two or three times in sorting yards before they reach their railhead. From the point of view of size, apart from the fact that the use of larger craft would involve the costly rebuilding of our canal system, it is doubtful whether larger craft would be generally suitable for our needs. Thirty tons on a single boat, or 55 tons on a pair, represents the maximum bulk cargo required at a time by the majority of actual potential users of canal transport. The use of much larger craft might thus involve the splitting up and redistribution of cargoes with unnecessary transhipment and delay similar to those occasioned in railway marshalling yards.

As outlined previously, the waterways have suffered up till now owing to the absence of uniformity and through working facilities, and to cut-throat competition with road and rail haulage, all caused directly or indirectly by diverse, and especially railway, control. If, as is now suggested, the inland waterway system is nationalised, these obstacles would be removed. In that case the waterways would be publicly maintained like the roads, and the

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canal user, like the road user, would pay a tax or toll for his craft which would enable him to travel anywhere on the system. It is submitted that the Government should not interfere more than is absolutely necessary with the freedom of the canal trader. The Canal Joint Committee should be relied upon to determine fair and equitable rates for canal carriage, and to ensure that these rates were observed. These rates should be such as to ensure a fair livelihood for the small operator—the owner boatman or "by-trader."

How should the public control of the waterways be administered? It should be obvious that so complex a matter involving intimate knowledge of the many factors and particular local conditions involved cannot be centrally controlled effectively. Regional control is essential. The most obvious method of defining such regions is the by the main Catchment areas. It is suggested that in each region a Catchment Board should be responsible for all problems relating to the use, disposal and conservation of water resources within their area. It is further suggested that the Board should be composed of representatives of all the sectional interests involved, and that where possible such representatives should be proposed for election to the Board by these local sectional interests, and not by central authority. In this way the Board would represent the maximum local knowledge and experience, and enjoy the confidence of the locality.

It is to be feared that the nationalising of waterways under centralised control, assuming present notions of economy and trade, may result in a ruthless policy of abandonment. It is the opinion of the writer that this course would be most short-sighted and unwise. Apart from the potential use of canals to relieve road congestion, the following considerations should be carefully weighed in the light of the fact that it is much easier and cheaper to maintain a waterway in navigable condition than it is to restore it to such condition after it has been abandoned, even for a few years.

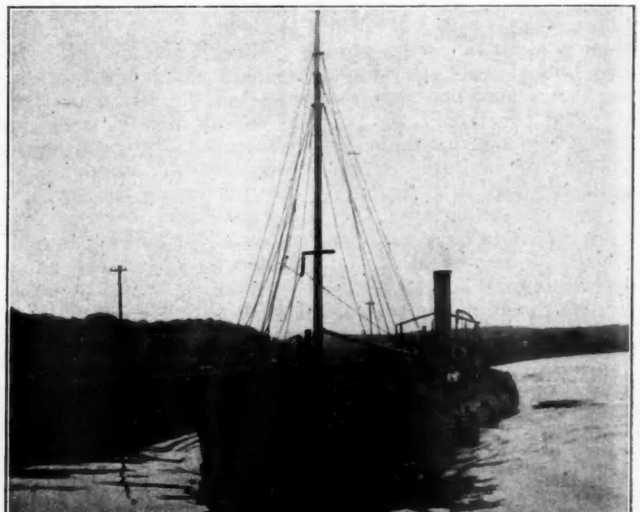
The fact that a waterway does not correspond with the present trade routes is not necessarily a conclusive argument for its abandonment as a navigation. Present trade routes may alter radically within the next few decades; they have evolved to meet the needs of an over-centralised economy based on expanding overseas trade. This period of expansion is over, and the future may witness the re-development of internal resources, the return to a regional economy and a more equable distribution of population.

Many canals which at present serve little or no useful purpose might become of great value in such an economy precisely because they were originally built to serve the needs of the similar regional economy which existed before the Industrial Revolution. Their tortuous character was determined, not only by the desire to save locks and earthworks, but also by Brindley's declared axiom that the canal should serve the widest possible rural area. Local records show that village wharves now disused once formed centres of local activity.

Even if such future use for a waterway cannot be foreseen, the following questions should be asked before abandonment is decided upon. Is it of potential value for water conservation, land drainage or irrigation? Would other waterways be adversely affected? What would be the consequences to the existing system of land drainage?

Similar considerations apply to waterways very recently abandoned. In the case of still water canals long long abandoned, the following considerations apply: Are they of any potential value for land drainage or irrigation? Do any sections still contain water? If so, where does it come from and is it quite stagnant? If all or part of the canal bed can serve no useful purpose it had better be filled in, especially if it contains stagnant water.

If it is considered that a still water canal can play a more useful part in the regional economy, the following questions should be investigated: Would the water supply be adequate to meet the demands of the volume of traffic estimated? If not, as the canal was originally built to handle a considerable traffic, why then is its supply now inadequate? Is it due to neglect of reservoirs, feeders or pumps, or is it due to conflicting demands for other purposes? If due to the latter cause, can these demands be reconciled? If not, could the difficulty be overcome by new feeders, or by reducing the consumption of water on the canal itself by means of side ponds, duplicate locks or pumping back? Does the canal need dredging to enable boats to travel freely when carrying maximum load? If so, what was its original maximum depth. It is important to know this, for if the canal is dredged beyond this maximum, the puddled bed will be dredged up and the canal will leak. Can the work of dredging be carried out effectually with the canal's existing equipment? If not is there equipment in possession of other local authorities (drag-line excavators) which might usefully be employed? What is the bulk of the canal's traffic likely to be, long or short distance? If short distance the use of horse-drawn craft should be considered, but if many motor-driven craft are to use the canal, some form of bank reinforcement should be advocated. If it is possible that the canal may handle a short distance "shuttle" service, as between a town and the village wharves of a "service" agriculture zone, are there adequate facilities for boats to "wind," i.e., turn round at village wharves? If not these should be made or existing but disused "winding holes" dredged out.



Standard Cargo Boat on Weaver Navigation

So far, the recommendations outlined reflect the belief that the major reconstruction and enlargement of our waterway system is not justified or necessary, but that if the waterways were reorganised and restored to full working efficiency they are capable of playing a valuable part in the regional economy. If such restoration were carried out and a greater volume of traffic consigned by waterway, the following improvement or innovations are worthy of future consideration:

Where a narrow canal carries considerable long-distance traffic consisting of paired boats, the substitution of wide locks with side ponds for narrow locks should be considered. Where the canal carries considerable single-boat traffic, the duplication of narrow locks on the side pond principle would be the better development. Little or no more water would be consumed. Where a compact flight of locks was to be altered in this manner it might be feasible to build fewer and deeper locks. Many existing locks have a fall of only 6-8-ft., whereas a fall of 12-14-ft. should be quite practicable, and by providing sluices of ample size, they should take no longer to fill or empty than shallow locks. The use of cast concrete gates of the guillotine type, i.e., working vertically in guides and counter-balanced, should be considered when lock rebuilding is contemplated especially on river navigations because both top and bottom gates can be lifted in emergency to liberate excessive flood water.

Future of Inland Waterways—continued

With regard to the handling of water-borne cargoes, the application of the road-rail container principle should be considered. It is suggested that these containers should consist of rectangular steel boxes of between 3 and 4 tons capacity designed to fit the standard narrow boat hold to the number of seven in a motor boat or eight in an engineless craft. They should be of welded steel construction with the minimum of internal and external projections apart from lifting rings at top. The bottom of the container should hinge down, also one side. This would allow of easy cleaning and would enable loose bulk cargo to be discharged through the bottom, or cargo in cases or other containers to be loaded or unloaded from the side. While the pay load of the boats would be reduced by the unladen weight of the containers it is submitted that the scheme would possess many advantages. The difficult job of cleaning out boat holds when changing over from one cargo to another would be eliminated. Cargoes susceptible to damp (e.g., cement) could be carried without risk. Containers could be easily transhipped by means of a light crane to barges, seagoing vessels, railway wagons or road vehicles and could be of convenient size, e.g., light, medium and heavy. Road vehicles would handle one, two or three containers respectively. Labour would not only be saved in loading, but boats would not lie loading for long periods, they would merely exchange containers. For canal transport between an urban area and an agricultural "service" zone as suggested above, such a container system would be of the greatest value, as the individual container would represent a convenient load for the average farm, and one easily handled by farm transport such as a tractor and trailer. In this way a container could be loaded with produce at the farm and delivered to its destination with the minimum of handling. In the case of easily-damaged produce such as soft fruit the advantage of the canal as opposed to any other form of transport cannot be over-stressed. In the case of return traffic from town to country, a 3-4-ton container load of coal, lime, composted sludge or other manure would represent a convenient consignment from the point of view of the average farmer. The only equipment necessary at village or farm wharves would be a small 5-ton crane for swinging the container. This could be operated by hand, electricity or small petrol engine and worked by farm hands and/or boat crews. At collieries or waste disposal plants, containers would be transferred from boats to rail trolleys, tippled and re-filled from hoppers or chutes while the boat was shipping further containers already so loaded. No time would be lost by boats in loading and unloading small quantities at different wharves with the attendant difficulties of intermittent labour, the need for weighing, trimming cargo, etc. By means of a high-pressure hose, containers could be easily cleaned down and made suitable for a different type of load.

Proposed Harbour of Refuge at St. Ives

Excerpts from a Report by the Joint Committee of Cornwall County Council and St. Ives Corporation

Introduction

For a century-and-a-half the precipitous coast of North Cornwall and Devon—from Land's End to Hartland Point—has been described as "The Sailor's Grave"; and not without reason, for during that period scores of ships and hundreds of seamen have been lost along this hundred mile stretch of picturesque but dangerous coast because of the absence of safe harbour accommodation.

Historical Data

Emphasis should be given to the fact that in accordance with repeated recommendations by various official and unofficial bodies, St. Ives is the most suitable place for this proposed Harbour of Refuge; it is situated on the North Coast in close proximity to the greatest sources of danger, the Land's End and The Stones; it has good transport facilities and the resources of the town are available.

The Select Committee of 1857 reported in favour of expenditure amounting to £174,000 at St. Ives for this purpose. The Royal Commission appointed on the advice of the Select Committee in 1858 issued, in the following year, a report containing the informed conclusion that if any Harbour of Refuge was to be constructed, its location at St. Ives was paramount to all other sites; the Select Committee added that £400,000 be so spent in its provision.

In 1776, the famous Engineer, Smeaton, advocated the construction of a harbour at St. Ives and the pier now known as Smeaton's Pier was constructed. In 1889 the Smeaton's Pier was extended, and in 1893 the West Pier was constructed.

In 1906 the County Councils of Devon and Cornwall engaged an eminent engineer, the late Sir William Matthews, to prepare a report on the subject. After exhaustive enquiries and investigation he came to the conclusion that better harbour accommodation was urgently needed at St. Ives, but on the ground of economy no national action was taken.

In 1919 the Development Commissioners secured a report by the Chief Engineer to the then Irish Department of Agriculture, and he suggested a scheme estimated to cost then some £60,000 as a means of providing some sheltered area of water where boats could wait for the tide. It failed, however, for lack of Government support.

The years 1923, 1926 and 1929 saw further strenuous efforts to obtain national recognition of the need for adequate harbour facilities off the Land's End Peninsula.

In March, 1930, representatives of the Chamber of Shipping of the United Kingdom visited St. Ives upon the question of harbour facilities.

The deputation found that the various alterations to the harbour in past years, and especially the destruction of the old outer breakwater, had rendered the harbour dangerous in bad weather. The deputation also found that during gales from between north-east and north-west the fishing and other vessels, if at sea, could not get into the harbour, and, if in the harbour, could not get out of it.

The resultant loss to the fishing industry alone was stated to exceed 20 per cent. and, added to this, the lifeboat in the harbour could only be launched with the greatest difficulty. Indeed, the absence of an area of sheltered water makes the launching of the lifeboat (whose services are, unhappily, frequently required) a highly difficult and dangerous operation.

The deputation concluded also that vessels out when bad weather sprang up from a northerly direction, "were in a very dangerous position as they were unable to run to their home port and there was nowhere else they could run for shelter."

This deputation suggested construction of a half-tide breakwater on the site of the old outer breakwater. The cost was then estimated at £45,000, and the deputation was strongly of the opinion that that scheme should have "the most sympathetic consideration" of the appropriate department of H.M. Government.

The great volume of expert opinion expressed in definite support of the construction of some form of breakwater at St. Ives is truly astonishing.

Shipping Traffic off the Land's End Peninsula

Some conception of the considerable increase in traffic at the South Wales ports during the war years is given by comparing the overall figure of 592,000 tons of general merchandise imported and exported during the 12 months prior to the declaration of war, with the figure of 2,935,000 tons in 1943.

During the period of depression before the Greater War, the traffic of the South Wales ports fell considerably, the annual total tonnage in the five years preceding the outbreak of hostilities averaging in the neighbourhood of 25,000,000. In periods of more normal economic conditions, however, the total yearly traffic amounted to somewhere around 44,500,000 tons.

It is officially estimated that the principal South Wales ports

Proposed Harbour of Refuge at St. Ives—continued

in one year prior to the second war were visited by approximately 24,000 vessels.

These facts alone are proof that the provision of refuge facilities on the North Coast of Cornwall as near to the open sea as possible is a matter of grave national importance, and is intimately bound up with the safety and prosperity of the great shipping traffic to and from this country.

The Need for a National Harbour

The construction of adequate harbour works is much too costly a project for local resources and, as such works are an urgent matter of public necessity in the interests of our sea-going population and the National security, this is a case where substantial assistance from the Government should be forthcoming.

The difficulties inherent in a tidal harbour, situated in an open bay, are being accentuated by continual silting which has reduced the time available for entry or departure of vessels to or from the present harbour by some four hours. During this time, boats returning from, or about to proceed to, the fishing grounds must lie outside. Frequently, the men must decide some four or six hours before starting time whether or not to take out their boats to the exposed anchorage. This silting, in part due to other natural causes, is largely increased by the destruction of the old breakwater.

The Harbour Authority have in mind certain preliminary plans and estimates, and are of opinion that the breakwater could be constructed with slight modification at a cost of not more than £480,000; this would afford the necessary protection to make St. Ives a safe Harbour of Refuge for the North Coast of Cornwall, and to render ingress and egress same for all vessels likely to need the facilities.

During the recent war 5,000 ships entered St. Ives Bay, many of which used the Harbour of St. Ives and Hayle. Large convoys sought shelter during winter months having to continue their voyage, however, at first sign of change in direction of the wind. At other periods of the year convoys entered by Naval instructions to avoid the enemy, and the harbour would have been used much more had the bay afforded better shelter.

With the still mounting evidence of national need for harbour protection off Land's End constantly forcing itself upon the public attention, in 1943, the St. Ives Corporation passed the following resolution:—

"That the St. Ives Corporation do take up the matter of the provision of a breakwater in St. Ives as a post war-development."

The Town Council endeavoured to view the matter as a proposal that might be included in the Government's present post-war reconstruction policy, and especially as a provision meeting the urgent need of that part of our Merchant Navy using the shipping lanes off the Land's End Peninsula.

The local authority saw three possibilities. They were:—

(1) A small scheme designed primarily to serve a larger lifeboat;

(2) A scheme of a larger type to fulfil the conditions of the first scheme and (in addition) to provide a moderately-sized breakwater.

(3) A scheme being a large national project which only the Central Government could finance.

There is no reason to suppose that the Ministry of Transport and/or the Ministry of Agriculture and Fisheries would be prepared to sponsor Scheme (1), as such a project would be the concern of the R.N.L.I. only. This would not apply to Scheme (2). Indeed, it is considered that Scheme (2) is the ideal scheme at which to aim. Such a project has been estimated to cost about £750,000, though, if about six or seven caissons (surplus to the Government's needs in (or available from) the invasion of France, or Phoenix Units could be purchased at reasonable cost, the above estimate might be reduced to about £480,000. The suggested structure is 1,500-ft. in length, 1,200-ft. being in sea beyond low water mark, and the end in 40-ft. deep water; it would give protection to Merchant vessels of 1/2,000 tons as well as to a launching site for the lifeboat; there would be a sheltered area of many acres, and should a further extension be required, this possibility is shown on the plan.

As to the question of cost, this scheme is regarded as an ideal objective, but nevertheless the Harbour Authority are very ready to recognise that something even smaller may be regarded by experts of the departments as adequate and effective for meeting the clear difficulties which the breakwater is intended to meet; if this were so, the Harbour Authority would not be found unresponsive.

The following resolution recently passed by the Cornwall County Council confirms the views of the local authority in relation to this subject.

"That, as much in the interest of safety of Cornish and other fishermen as in providing greater harbour facilities for fishing purposes, this Committee are in accord with the views of the Borough Council of St. Ives that a Harbour of Refuge should be constructed at St. Ives as part of the Government's post-war development schemes and they accordingly request the County Council and the five Members of Parliament for the Cornish Constituencies to support any proposals that may be made to that end."

Since 1938, three large steamers have been lost owing to lack of safe anchorage in St. Ives Bay. They are the *Alba* (6,000 tons), the *Wilston* (about 10,000 tons) and the *Riverton* (about 10,000 tons). The latter ship had been torpedoed, but succeeded in reaching St. Ives Bay. During temporary repairs the weather changed. Her Captain decided to attempt the voyage to a South Wales port. The steamer sank. The value of these three vessels and their cargoes would be more than sufficient to defray the cost of a breakwater to say nothing of the loss of 60 precious lives.

The Joint Committee is convinced that the case for a Harbour of Refuge at St. Ives is unanswerable at both local and national levels.

Correspondence

To the Editor of "The Dock and Harbour Authority."

Impact Stresses in Jetties

Dear Sir,—

A study of Mr Minikin's article in your July issue indicates that our difference of opinion as to the value of the procedure he suggests for full scale experiments and observations arises from an important difference of objective.

We are both agreed on the need to specify, as in a code of practice, some value for the normal velocity of approach and Mr. Minikin apparently considers that the average of a large number of actual observations will be appropriate. In my opinion, it is the maximum velocity for which it is economical to cater that requires to be determined, and the selection of this presents a problem which would only reappear, in a different form, at a later stage in Mr. Minikin's procedure, when he comes to decide on a suitable factor of safety. To take an imaginary example, it would be obviously unreasonable to design a jetty, whose useful life, allowing for such factors as obsolescence is estimated at 50 years, to resist an impact likely to occur only once in 80 years. On the other hand, it would not be excessive precaution to design it, at least to avoid major failure under an impact likely to occur say once in every three or four years.

The determination of the frequency with which an impact of any given magnitude is likely to occur is an exercise in probability, and the final selection, from a table of possible impacts and their probable frequency of occurrence, of a figure on which to base the design would be influenced almost entirely by considerations of the relative costs of new construction and repairs, a point to which Mr. Minikin does not refer in his article.

The remaining factors in the problem such as the loss of kinetic energy on impact, and the stresses produced in the structure are, I agree, suitable subjects for full scale experiments, but this, as I have already stated, should be by way of deliberate and controlled operations and not observations of chance selected cases of berthing which, in the majority of instances, will not produce the information required.

Yours faithfully,

J. H. JELLETT.

Docks Engineer's Office,
Southampton.

Wellpoint Dewatering System

By R. G. ATTWOOD, O.B.E.*

Excavations for trenches or for foundations have often presented problems to engineers, but when "running sand" has been unexpectedly encountered the problem became more serious, and often resulted in heavy financial loss, because all known methods of dealing with "running sand" entailed appreciable costs and delays. Revised plans of construction have often had to be considered with a view to avoiding subsidence of adjacent ground and consequent danger of nearby buildings becoming undermined.

Those who have carried out construction work in "running sand" know the difficulties to be encountered and the costs incurred. It is necessary to employ skilled timber men and use good quality timber, which is expensive and difficult to obtain these days; the timber must be tight-jointed so that the water and "running sand" will be withheld from flowing into the excavation, or, under worse conditions it is necessary to resort to steel sheeting or piling, with the requisite plant for handling and installing. All this causes delay and makes construction very costly. While these methods may prevent the sides of the excavation from collapsing, they do not dispose of the water at sub-grade, neither do they overcome the water outside the sheeting from percolating into the bottom of the excavation, and unless the sheeting is driven down to clay, or a solid bottom, "boiling" is liable to take place. "Boiling sand" is caused by external or upward pressures and it constitutes a still greater danger because this often causes a displacement of the ground in the locality; a movement, or collapse of the sheeting, or subsidence of the ground which, if adjacent to buildings, may have disastrous results with heavy liabilities to the contractor.

Owing to the consistency of "running sand" or "quick sand" —which are terms for a condition of material and not for a material itself—the concrete foundations of pipes may rise or sink after being laid, due to displacement of the ground, as it must be remembered that while it is not possible to compress running sand, it can easily be displaced when in a liquid state; the object therefore, is to consolidate the ground. A problem is always presented when using pumps in running sand; because of the difficulty of separating the water from the sand, the wear and tear on the pumps is heavy and there is the danger of pumping sand away from the excavation.

All this has been completely overcome by the introduction of the Wellpoint Dewatering system, whereby the water is extracted from the ground before the site is opened, thus enabling the work to be carried out in firm and dry ground, provided that the type of soil is such through which the water can percolate.

The principle is to "jet," by means of water under pressure, the wellpoints into the ground to a depth of about 3-ft. below sub-grade and to connect them to a main suction pipe, at ground level, which in turn is connected to the wellpoint pump, thereby extracting the water from the ground by suction under vacuum; the ground is thus made dry and firm to a depth well below the maximum depth of the foundations or trench before excavation takes place. These wellpoints are spaced according to the nature of the ground and the quantity of water to be extracted.

Before going further it would be as well as describe the equipment comprised in the wellpoint system; this is as follows:—

The Wellpoint, which weighs 11½ lbs., consists only of a centre pipe made of a strong section steel-fluted tube covered by a gauze screen of 50 by 50 mesh, and on the end is screwed a shoe. The point is fitted with a floating ball to prevent the return of ground water, which would otherwise not be filtered by the screen if taken direct from the point to the pump. Water enters through the screen, passes down the outside of the fluted tube and is drawn up through the centre of the wellpoint to the riser pipe, which is 1½-in. diameter.

Referring to Fig. 1, the wellpoint complete is shown on the left, in the centre is the fluted tube, and on the right is the gauze screen covered with a perforated brass sleeve. Below the gauze screen is shown the shoe, which contains a floating rubber ball valve.

The Riser Pipe is the direct connection between the wellpoint and swing joint that varies in length according to the depth to which the wellpoint is sunk. One man can comfortably carry 20-ft. of riser pipe with the wellpoint attachment.

The Swing is designed to give added flexibility and affords convenience in connecting the wellpoint system. Each "swing" is fitted with a union and a bronze stop-cock so that any wellpoint can be shut off, inserted or disconnected at will without interfering with the balance of the system.

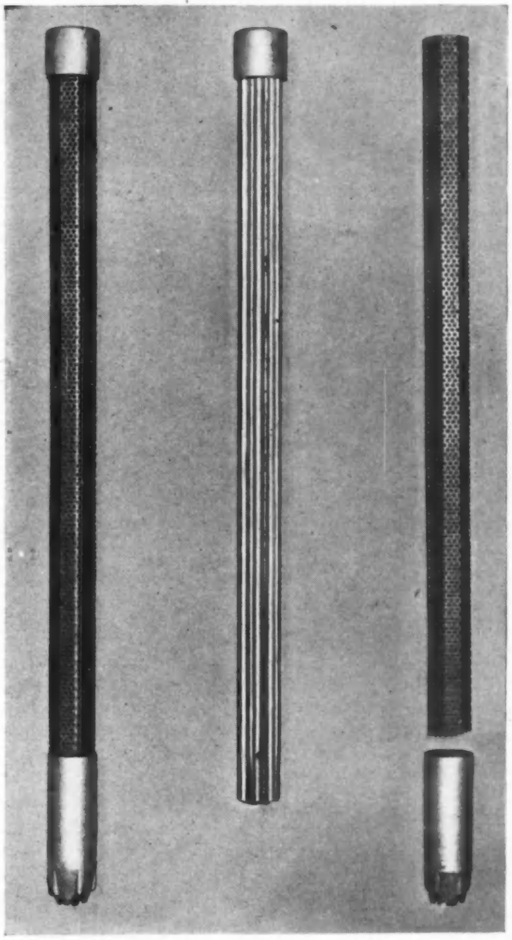


Fig. 1.
Left—The Complete Wellpoint. Centre—The Fluted Tube.
Right—The Gauge Screen with Protecting Perforator Sleeve and Shoe containing Rubber Ball Valve.

The Header Pipe is made of light-weight tubular steel 6-in. diameter and 20-ft. long, with bosses 30-in. apart, and is fitted with a plug.

The Header Couplings are of the two-bolt metal and rubber sleeve type and are used to connect the header pipe, valves and fittings to make the assembly of the system a speedy, simple and flexible process.

All header fittings have unthreaded ends so that the same type of coupling can be used uniformly throughout. This feature applies also to the gate valve, which has short adapters with plain ends, and is thus quickly coupled to the system. Rapid progress, both in installation and removal in thus ensured with this type of coupling, which is air-tight and flexible under pressure or vacuum. Bends, tees, blank ends are also required to complete the system.

Pumps.—Two sizes of pumps are most commonly used in the wellpoint system: a 6 or 8-in. self-priming centrifugal pump, the pump, the 6-in. being the most popular under normal conditions.

*Paper read at a meeting of the Junior Institution of Engineers, London, and reproduced by permission.

Wellpoint Dewatering Scheme—continued

The suction of the pump is delivered into an air-extracting chamber, fitted with a grid to break up the water, and connected to this chamber is a powerful vacuum pump, which causes a 27-in. vacuum to be maintained in the whole system; a Peeler valve is incorporated to prevent water from entering the vacuum pump, and thus the efficiency of the pump itself is increased. It will be realised that with a large number of wellpoints and a correspondingly long suction line there is the possibility, not only of air leaks in the pipe line, but of air in the water, and a very efficient air-extracting pump, capable of dealing with 96 cub. ft. of free air per minute, becomes necessary.

The suction pump is of the centrifugal single impellor type, having a capacity of 1,000 gallons per minute at 40-ft. head, and it has a 6-in. suction and a 6-in. discharge. A control valve is fitted to the delivery pipe in which there is a $2\frac{1}{2}$-in. connection for "jetting" purposes at pressures up to 20 lb. per sq. in. The pump is fitted with a cooling radiator and requires a prime mover of 32 h.p., which may be a petrol or Diesel engine or an electric motor.

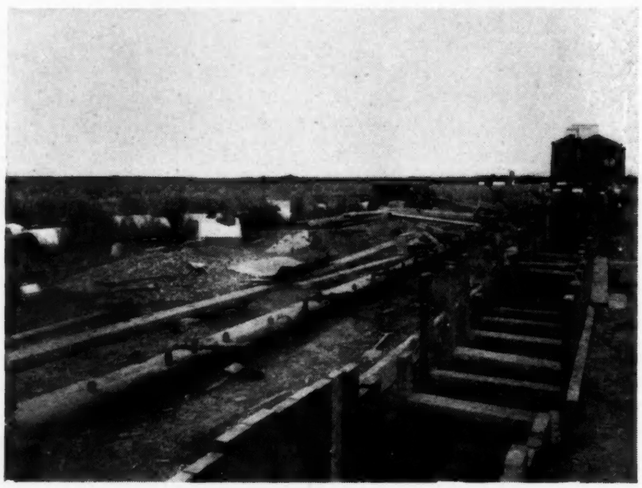


Fig. 2.—Progressive System of De-watering as used in the construction of Trenches.

Jetting.—The operation of inserting the wellpoint into the ground is known as "jetting." It is effected quite simply by forcing water under pressure from the jetting pump or hydrant, down through the riser pipe into the end of the wellpoint. Where high pressure is required, e.g., in large or fine gravel or clay, a pressure of from 80 to 150 lbs. may be necessary, but more usually a pressure of about 100 lbs. will be found sufficient, and the wellpoint will be washed down into the ground.

In running sand or coarse sand very little jetting is necessary and 20 lb. pressure would be sufficient, and this can be obtained by the suction pump, thereby avoiding the use of an additional pump.

The connection from the jetting supply to the riser pipe is through armoured hose in 50-ft. lengths, the last length being canvas rubber-lined hose pipe of good quality to withstand the pressure.

When the wellpoint is placed in the desired position with the riser pipe attached to the jetting hose, the water pressure is turned on and the force of the water discharged at the wellpoint tip washes out a hole from 8-in. to 12-in. in diameter in the soil, and the wellpoint sinks to the desired depth. The water is then turned off the hose disconnected and the riser pipe is connected via the swing connection to the header pipe. This is repeated until all the wellpoints are in position.

A supply of water from a hydrant or a local stream is necessary for jetting the first twelve wellpoints, after which the suction pump can be put into the circuit and a supply of water drawn from the wellpoints by the pump and delivered to a storage tank to form a water supply for the jetting pump when high pressure is required. For low-pressure jetting in sand, the water can be delivered direct from the suction pump, through the delivery hose, to the wellpoints that are to be inserted, and thus a considerable saving can be effected in the quantity of water used for jetting. Water can also be saved by employing a boring tool to bore through clay or hard formation near the surface to reach the water level.

Installation.—There are two methods of installing a dewatering system, viz.:—

1. The progressive system, which is used in the construction of trenches.
2. The ring system, which is used when excavating an area.

For trench construction, the header pipe is placed alongside the trench as near the side as possible, as shown in Fig. 2. In difficult ground, and for trenches over 20-ft. deep, the header pipe is placed in the trench and supported on struts, the trench being excavated by grab. If, however, a mechanical digger or excavator is used, then the header pipe must be laid at ground level, outside the track of the digger.

The wellpoints should be placed from 2-ft. 6-in. to 5-ft. or even up to 15-ft. apart, according to the nature of the ground and the quantity of water to be dealt with. In fine running sand 10-ft. apart is usually necessary for perfect dewatering, but in loose gravel and coarse sand, when a large volume of water is encountered, the wellpoints may have to be as close at 2-ft. 6-in. The tip of the wellpoint is jetted to a depth of 5-ft. below invert level where possible. The header pipes and wellpoints are placed ahead of the excavation of the trench so that they can be withdrawn as each section of pipe laying is completed and reinserted ahead of where digging operations are to take place, and thus the ground is dewatered prior to being opened.

It is usual to lay out 300-ft. of header pipe, whereby 120-ft. of trench can be opened and the pipe line laid; 80-ft. will be in process of transference, and 100-ft. re-inserted and dewatered ready for the next day's work. By this means it is quite an easy matter for trenches 17-ft. deep, in running sand, to be completed at the rate of 80 to 180-ft. per day.

With the pump on the surface, the greatest effective depth of trench would be 20-ft., but if the number of wellpoints is reduced, it is possible to dewater to a depth of from 23 to 26-ft.

When laying out the system, a Tee-piece should be placed in the header pipe line at a point 100-ft. from one end, with a valve on each side of it. A second Tee-piece with two valves is placed a further 100-ft. away, so that the pump can be moved easily from one set-up to the second set-up, with the minimum delay. This arrangement enables the change-over to be effected as quickly as possible without the water rising. The end valve is shut while the wellpoints are withdrawn up to the valve, and are then replaced at the far end of the header pipe line. By this method, the work of withdrawing and re-inserting can be carried out while the system is in operation.

Trenches up to 5-ft. or 6-ft. deep often require no timber or shuttering of any kind, particularly if the sand or silt is very fine. With coarse sand, the sides may fall when dry, and therefore, in such cases skeleton timber is advisable. For depths of from 17 to 20-ft. in fine silt or sand timber spaced at one yard apart will usually prove sufficient, and it need not be carried lower than a depth of 4-ft. from the bottom. Precautions must be taken, however, to see that the ground is not likely to fall due to its dryness, and that there is sufficient support to carry the weight of the excavated material placed at the side of the trench; it must resist any vibration which might be caused by a mechanical digger or damage caused by surface water due to storms. Trenches up to 22-ft. deep can be constructed by "battering" the sides, without the use of timber, if the width of the trench is 10-ft. at invert and 20-ft. at the surface; the excavation being carried out by dragline.

Labour.—Four men and a wellpoint supervisor are all that are necessary to handle the system and keep ahead of the pipe laying. It is most important that they should always be well ahead of excavation because the inserting of wellpoints after the excavating would cause breaking away of the sides and flooding of the trench.

Wellpoint Dewatering Scheme—continued

The Ring System is an entirely different proposition since it is permanently installed during construction. Whether it be a small area of 20-ft. by 20-ft. or a very lage excavation, it is only a matter of the number of pumps, wellpoints and header pipes, and it can be laid out in any irregular shape or even circular.

The method is to "ring" the whole area with the header pipes outside the building line, as shown in Fig. 3. The sides of the excavation should be battered wherever possible and always where sand exists to the full depth, the amount of "batter" depending on the type of the ground. The sides can often be quite steep when the ground has been dewatered, and by this means timber and steel sheeting can be entirely eliminated for depths up to 20-ft.; the header pipe line being "ringed" round the area to allow for this.

In a confined area where it is not possible to "batter" the sides, a vertical excavation is essential, then timber and steel sheeting must be resorted to, although in many cases this need only be skeleton timbering.

Wellpoints are sunk to a depth below the sub-grade and spaced according to the nature of the ground and the quantity of water to be dealt with, which also determines the number of pumps necessary. Each pump should be placed so that approximately an equivalent number of wellpoints are on each side of it. One pump is capable of dealing with from 50 to 70 wellpoints, according to conditions.

Once the wellpoints have been installed there are no further costs other than maintenance and the man in charge of the pumps, which must be attended day and night, for once the water has been lowered in the area the pumps must be kept working continuously —24 hours per day—until the work of construction is completed up to water level.

When the depth of excavation is to exceed 18-ft. below water level, it is advisable to excavate the area to water level and "ring" the area at this depth, and should it be necessary to excavate deeper than 18-ft., say to a depth of 36 to 40-ft., the top area is dewatered and excavated first, then the area is again "ringed" at the lower level. By these methods excavations have been carried out to depths of 50-ft. or more.

The wellpoint system cannot fail in any form of "running sand," provided that the running sand is encountered below invert level of the trench or the sub-grade of the excavation. It is, however, unsuitable where the wellpoint encounters clay, since the water will not percolate it, but so long as the wellpoints are in sand the clay above can be penetrated by jetting. It is also not possible to operate wellpoints in rock or hard material, or amongst large boulders with an absence of sand, which would make it impossible to insert the wellpoints by jetting; but in ground of this nature special jetting or boring apparatus is provided to penetrate difficult material.

The fineness of the sand or silt is no deterrent, as in such cases the wellpoints are "sanded" in. This is done by placing a small quantity of sharp sand round the wellpoint to act as a filter to the fine material and preventing it from entering the system. Even if the silt is as fine as 200 mesh, the discharge water from the pump will at all times be crystal clear in from 10 to 15 minutes after pumping is commenced, and no sand will be discharged by the pump. The discharge water should be led away from the site to a local stream or drain, or over the ground sufficiently far to ensure that it will not flow back to the site, and the distance need not be great if clay is on the surface.

When pumping is commenced the water will be seen to be gradually lowered in the ground and this may be observed by means of test holes spaced at varying distances apart. In certain types of ground the water will be lowered for many hundreds of feet in each direction, and the longer the system has been pumping the more the water will be lowered and the greater distance away this will be observed.

In sand with a complete absence of clay, the water will be lowered very rapidly, sometimes within twelve hours in the locality of the wellpoint, but in more difficult ground where percolation is not so free, several days may be necessary. Once lowered, the water will take considerably longer to flow back to the site than was taken for its extraction, which is due, of course, to the lowering of the water table in the ground and the consequent reduction of pressure.

To obtain perfect results it is essential that the wellpoints should be installed below sub-grade. If "running sand" exists above clay, and the invert level is in clay, the ground can only be dewatered to within 6 to 9-in. above the clay, and with such a condition there is bound to be a slight seepage owing to the fact that there is insufficient water flowing to the wellpoints to prevent the drawing of air. Although the water table has been lowered to this level and the pressure thereby reduced, it will be found necessary to use timber in the bottom of the excavation.

The withdrawing of the wellpoints is a simple matter; when jetted with sufficient water pressure they can usually be pulled out by hand. If, however, difficulty is experienced, it is speedily overcome by the use of a withdrawing tool.

Regarding the operating costs of the wellpoint system, these must, of course, depend entirely on the nature of the undertaking, the type of ground and quantity of water to be dealt with, which controls the number of wellpoints, pumps and other equipment which will be required, and, therefore, estimates must vary with every contract. It follows that each problem must be considered on its merits. It is sufficient for the purpose of this paper to assure the reader that with the use of this system very considerable savings are effected. This economy, it will be readily understood, is due to the following:—

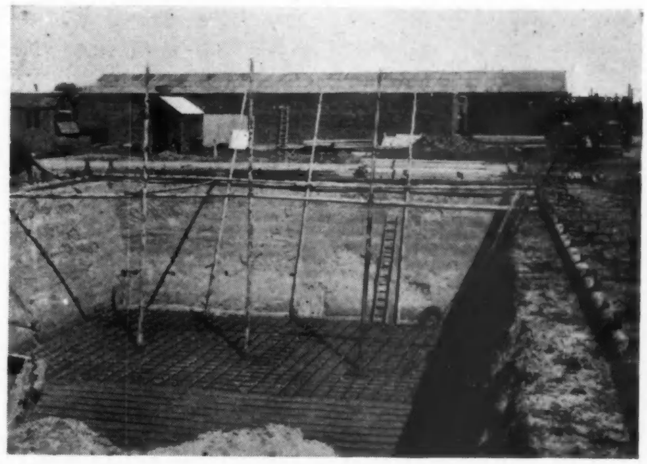


Fig. 3.—Ring System of De-watering as used in Excavators.

1. Although working in "running sand" the conditions of excavating are the same as digging in dry ground.
2. If a mechanical excavator is used, instead of first digging only to water level and then employing hand labour, it will be possible to dig the full depth of the trench in one cut, which often reduces the cost from 1s. 3d. to 2½d. per yard.
3. In most cases it has been found possible to trench to a depth of 5-ft. without using timber. A depth of 10-ft. can be excavated if the sides of the trench are battered, and in deeper trenches the support can usually be reduced to skeleton timber.
4. As the pipe is in dry ground the making of joints and the guarantee that they will be satisfactory becomes a simple matter.
5. No sinking of the pipe takes place after laying, as is the case when working under wet conditions, and a perfectly true pipe-line can be assured.
6. When excavating without wellpoints in front of a pipe-line that is being laid in "running sand," the sand and water flows from under the pipe already laid causing it to sink and to become irregular and so fracture the joints, which results in the pipe-line being condemned, and it must be re-laid. This risk is entirely eliminated by the wellpoint system.
7. The sides of the trench will remain firm and falls will be avoided.
8. The likelihood of subsidence and consequent damage to buildings or roads in the locality is removed.

Wellpoint Dewatering Scheme—continued

9. Working under dry conditions often enables work that would take months to complete can be carried out in a matter of weeks, and frequently work estimated to take two months has, due to the employment of this system, has been completed in four days, and certainly under a week, with the consequent reduction of overheads.

Many contracts which would have been impossible to accomplish by employing usual methods or would have been too costly, have, by using wellpoints, been both cheaply and successfully carried out.

The wellpoint system has been developed to the highest point of efficiency, and has been successfully used for dewatering excavations for:—

Bridge foundations, Buildings, Cellars, Cofferdams, Disposal plants, Dry docks, Footings, Land reclamations, Locks, Permanent water supply systems, Pumping stations, Sea walls, Sewers, Stabilising ground under buildings, overcoming subsidence, Storage dams, Subways, Swimming pools, Underpinning work, Water-bound ground where excavation is necessary in running sand.

The wellpoint system can also be used as a permanent pumping installation, and many successful plants are in operation in this capacity. The object is not to dewater the ground but to extract the amount of water required without unduly lowering the water table in the ground. To accomplish this the wellpoints are spread out at a determined distance apart on a long header pipe-line. These points may be from 20 to 30-ft. apart, according to the quantity of water in the ground and the rate of percolation to give the quantity per hour required. The plant may be operated over a given number of hours per day. If the plant is not in operation at night the water will flow back to its permanent level during the hours of rest and accumulate.

One plant in operation is designed to give 15,000 gallons per hour, 24 hours per day. It is installed in a stratum of gravel and sand, which is free percolating; the whole plant is entirely automatic and electrically controlled and delivers the water to the factory at 100 lbs. pressure. When the pressure drops to 60 lbs. the wellpoint pump is started and delivers water to a 1,000-gallon tank, electrically float-controlled which, when full, automatically starts a high pressure booster pump for delivering the water at 100 lbs. pressure to a 33,000-gallon storage tank. When this tank is full at 100 lbs. pressure the plant remains stationary until the pressure drops to 60 lbs. Over a long period it is estimated that the water costs have been reduced to 2¼d. per 1,000 gallons.

Another system that has been installed is capable of giving an output of 18,000 gallons per hour, and another from 8,000 to 10,000 gallons per hour for ten hours; and 150 sets are being installed to give 3,000 gallons per hour with ten wellpoints and 100-ft. header pipe-line. The pumps employed are self-priming and capable of maintaining a high vacuum of 27 to 28-in.

The wellpoint installations are most useful in outlying districts away from water supplies, where permanent water level exists within 12-ft. of the surface. They can be used on farm sites for watering cattle or in nursery gardens for watering crops. A battery of two or three wellpoints can be installed over an area, such as a golf course, where small quantities of water are required for watering the greens, and a portable pump is taken to each battery of wellpoints.

Water is always filtered and crystal clear, and unless chemicals are present in the ground, is suitable for all purposes.

Wellpoints are now used by contractors in this country, especially on Government work in connection with aerodromes and Royal Ordnance Factories, and their use is appreciably accelerating the work.

Inland Transport and Coastwise Shipping

Proposed New Measures of Co-Ordination

Agreed proposals for new measures of co-ordination between road and rail are contained in a memorandum which has been submitted to the Minister of Transport by the main line railways and the Road Haulage Association.

These proposals are the result of discussions begun before the war and continued so far as circumstances allowed. The formation of the present Road Haulage Association in January, 1945, facilitated progress, and in May, 1945, fresh conversations were initiated between the general managers of the four main line railway companies and the new association.

These conversations had the support of the then Minister of War Transport, Lord Leathers, and have continued with the approval of the present Minister of Transport, Mr. Alfred Barnes.

An agreed scheme has been evolved for the co-ordination of all road and rail freight transport services. Under this scheme the road haulage industry, for the first time, largely accepts the obligations of a public service.

The scheme will necessitate some revision of existing legislation, including amendment to the Road and Rail Traffic Act, 1933, and certain relaxations of statutory restrictions upon the railways, as envisaged in the road-rail agreement embodied in the 1939 report of the Transport Advisory Council.

It is considered that the proposals in the new agreement would achieve a large measure of co-ordination with a minimum of disturbance. They leave ample scope for free enterprise on a fair and competitive basis and go far to eliminate the evils of unregulated and wasteful competition.

Since the proposals were formulated, it has been agreed to extend them to cover the inland waterway and coastal shipping interests, both of whom support the scheme. The present agreements between the railways and (i) coastwise shipping and (ii) the Canal Association will require to be replaced by agreements on a wider basis embracing road interests, these agreements to be subject to the approval of the proposed Road/Rail Tribunal.

The proposals are approved and endorsed by, amongst others, the Association of British Chambers of Commerce, the Federation of British Industries, the Traders' Co-ordinating Committee, the National Union of Manufacturers, and the British Road Federation.

Views of the Chamber of Shipping

The coastwise liner and tramp sections of the Chamber of Shipping in commenting on the proposals state that the coastwise shipping industry has for long regarded the closer co-ordination of road and rail as a first step towards co-ordination of inland transport with coastwise shipping, and the Minister has been advised that the proposals are regarded as a major step forward, but that it will be essential that the competitive position of coastwise shipping be sufficiently safeguarded in relation to the operation of these proposals.

It will be necessary, for example, that coastwise shipping should be adequately consulted during the formulation of the suggested new road and rail rates structures respectively in order that the rates for all forms of transport, including coastwise shipping, may be properly correlated.

Further, it will be necessary to provide that any new tribunal set up should include a member with expert knowledge of coastwise shipping when its interests, direct or indirect, are under discussion.

On these and other matters the Chamber of Shipping has assured the Minister that the industry will be prepared to make proposals to the Ministry when required.

Meanwhile, conversations are proceeding with the railway companies and the Road Haulage Association for the establishment of wider and more comprehensive conference agreements than those existing between rail and sea only prior to the war, the new agreements to embrace all forms of transport. With such machinery, and through the organisation of shipowners in the Chamber of Shipping, effect can be given to rate agreements reached between coastwise shipping and other forms of transport.

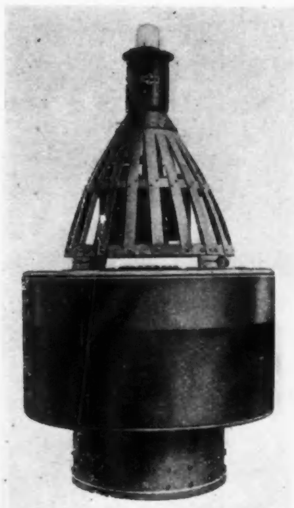
Electric Lighting for Marine Buoys

Description of a Recent Development

By DR. WALTER L. STERN, A.M.I.E.E.

It is well known that during the war, British engineers developed with great success, various navigational aids, and one of the foremost of these was RADAR. Recent tests made by the Admiralty in conjunction with the Ministry of War Transport, have proved that a Radar Set has been designed which will be suitable for general installation in ships of the Mercantile Marine. On the screen of the Radar receiver installed on board ship,

Deep Draft Gas Buoy converted into Independent Electric Lighting System. Note Battery container inside float chamber. (Photo by courtesy of Colchester Corporation.)



Shallow Draft Buoy, fitted with Londex Independent Electric Lighting System. Note the Battery container inside Day mark.

prominent landmarks, buoys and other ships can be seen, but it is not possible to distinguish between ships and buoys. To overcome this drawback groups of buoys were laid in geometrical patterns, for instance, in "T" form or in a triangle, and in this way each group of buoys was easily distinguishable from the pin-points of light which represent ordinary buoys and moving ships on the Radar screen. From these tests it became apparent that despite the remarkable success of Radar, it would not be possible, at least for some long time, to do away with the navigational aid familiar to every seaman, that is to say, the lighted BUOY AND BEACON. Furthermore, for some time to come, it will only be possible for the big ships to be fitted with these comparatively complicated and expensive Radar equipments, so that the smaller ships will still have to depend entirely on buoys and beacons.

However, during the years of war, remarkable progress has been made in this field, because of the urgent need for navigation lights which could be instantly extinguished in the event of approaching enemy aircraft. It is obvious that the old buoys and beacons with their discerning signals would have allowed enemy aircraft to check their positions and thus find their targets with comparative ease. On the other hand navigation lights on sea were not only required by our ships, but more particularly for our sea-based aircraft. It is essential that for taking off and landing on sea-dromes at night some lights are provided, at least for the flarepath, the landing lanes and obstructions. Obviously the existing oil and gas burning lights were unsuitable, as they could not be controlled with the necessary speed and efficiency, so the new electric battery lighting system was developed.

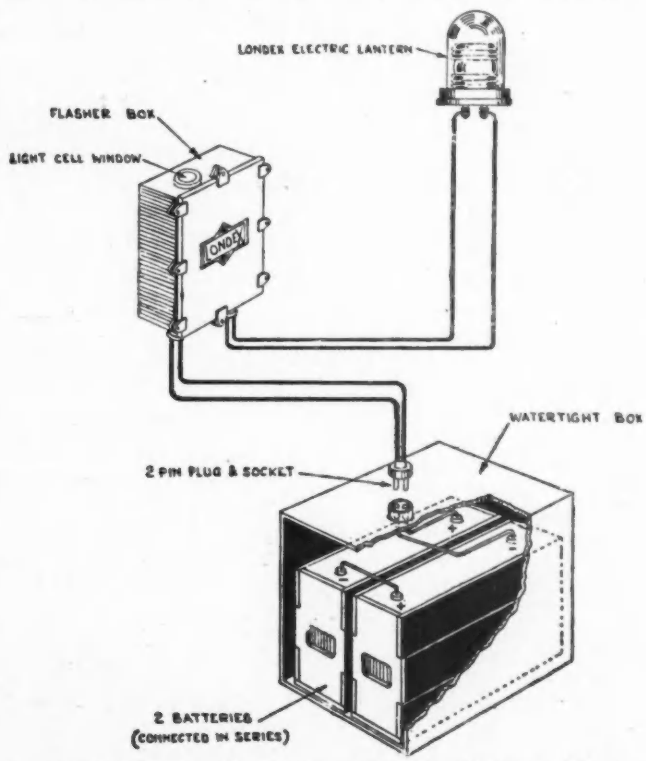
Electric Control

Two new methods of switching on and off electric lighted buoys were practised during the war. One method provided electric buoys with an easily accessible switch which was operated by service personnel of a Motor Boat Patrol. The other method incorporated a new type of remote control, whereby a push button was pressed on shore, and the navigation lights at sea were switched on and off at will. This remote control system has proved itself extremely suitable for the operation of flarepath lights on sea-dromes, where during hours of darkness, certain groups of these lights have to be switched on and off according to variation in wind direction when aircraft are landing or taking off.

The advantage of using electricity as an illuminant for buoys and beacons are so numerous that since the cessation of hostilities, the demand for this new system has expanded, and many Harbour Authorities are converting their existing gas and oil Marine Lights into the new battery operated electric system. The electric light is visible from above as well as in the horizontal plane. An ingenious and simple electric flasher gives these navigation lights any specified flashing character, which if required, can be easily varied.

All Steel Batteries

A specially powerful all-steel battery, capable of withstanding severe conditions met with at sea is incorporated. This battery, unlike the ordinary car accumulator, does not deteriorate, and



Arrangement of connections between Batteries, Flasher and Lantern

requires re-charging only every one or two years according to the flashing character of the light. Re-charged on shore from the mains supply, the cost of electricity for re-charging these batteries is almost negligible.

General Arrangement

The diagrammatic sketch shows the simple arrangement provided by this new system. There are two all-steel batteries housed in a water-tight container. Two wires connect these batteries with

Electric Lighting for Marine Buoys—continued

the flasher box, which is a water-tight casing into which is fitted the automatic "on" and "off" flasher. In addition, there is incorporated the automatic Night/Day switch which is actuated by daylight entering through a small "light cell window" provided for the purpose. From the flasher box two wires lead to the electric lantern which is fitted with a special filament lamp mounted inside a lens. The size of the lantern, lens and electric lamp depends on the visibility required. For instance, a small 100 m.m. diameter lens gives a light which is visible up to eight miles.

The flasher serves two purposes. In the first place it saves electric current, thereby increasing the length of the run of the battery and decreasing the cost, and secondly gives the "light" the special flashing character which distinguishes it from surrounding lights. The simplest form of flashing character is a single flash, followed by a period of darkness, repeated at regular intervals. A certain amount of distinction can be given by varying the number of flashes per minute, but where there are many lights, it is often necessary to give a group flash, constituting a number of flashes in quick succession followed by a longer dark period. There is no difficulty at all in obtaining the most complicated flashing characteristics with the new electric flasher.

Another important device for saving electric energy, thereby increasing the length of unattended run, is the light sensitive control. This apparatus automatically switches the light off in the morning and on again at dusk or in the event of fog. It thus prevents the use of energy during the time when the light is not required.

There are two ways of mounting the battery container on the buoy. One of the illustrations shows the shallow draft buoy with flat bottom, which is suitable for shallow waters and which will rest on the sea-bed at low tide if necessary. The battery container can clearly be seen inside the conical Day Mark. The other illustration shows a deep draft old type gas buoy, recently converted into electric lighting. It will be of interest to note that in this case, the battery container with batteries is fitted inside the float chamber. On top of the Day Mark the flasher with automatic Night/Day switch and the lantern with conical cap will be observed.

Had it not been for the war, the introduction and change over from the gas and oil illuminant to the modern electric light on buoys would have taken a very much longer time. With our sea-lanes once more free from enemy aircraft and shipping, full navigational lighting is again being provided, and a number of Port Authorities are converting their old oil and gas buoys to the new electric system. Many hundreds of new and converted electric buoys and beacons are already in use for sea and air navigation.

New Channel at Entrance to River Tay

For some years prior to 1943, it had become apparent that considerable alterations were taking place in the positions and heights of the sand banks at the entrance to the River Tay seawards of Buddonness.

Periodical surveys of this extensive area (made possible by the installation of echo-sounding apparatus in the Dundee Harbour Trustees' survey vessel) showed that the eastern tip of the Gaa Spit was moving westwards and the Abertay Spit was increasing in height and extending in an easterly direction to join up with the tip of the Gaa Spit, thereby narrowing the navigable channel at this point.

It was also observed that a new channel appeared to be breaking through the Gaa Spit, practically on a continuation of the line of the Tayport Lighthouses, and in a due easterly direction from the position of the *Abertay* light vessel to the open sea.

At this time the main navigable channel followed the line of the Tayport Lighthouses from the Horse Shoe Buoy in an easterly direction to the *Abertay* light vessel, and from there ran in a south-easterly direction on the line of the Buddonness Lighthouses to the open sea.

Early in 1943, the new channel had broken through the Gaa Spit, but the depths in the channel were not sufficient for the passage of the larger vessels normally using the Port of Dundee, and it was decided to accelerate the natural deepening of this new channel by carrying out dredging operations.

For this purpose the Dundee Harbour Trust hired a trailing suction hopper dredger, and during the months of June and July, 1943, this vessel removed some 150,000 tons of sand from the new channel, which was brought into use in September, 1943. It has to be remembered that these dredging operations were carried out in open waters while the war was in progress.

The new navigable channel extends in a practically straight line from the Horse Shoe Buoy at Broughty Ferry to the open sea, and dispenses with the awkward 45 degrees bend (which occurred in the old channel at the Lightvessel), thereby rendering navigation of the river both easier and safer.

When the large scale tidal model of the River Tay (at present under construction by the Harbour Trustees) is put into operation the problem of these mobile sandbanks at the river mouth will be a subject of careful study, as a further measure of securing the maintenance of a safe and easy channel for shipping.